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9-731E

TM 9-731E

WAR DEPARTMENT TECHNICAL MANUAL

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CARRIAGE, MOTOR, 105-MM HOWITZER, M7

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WAR DEPARTMENT • *15 AUGUST 1944*

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W1,30,
9-731E

WAR DEPARTMENT TECHNICAL MANUAL

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This Technical Manual supersedes TM 9-731E, dated 5 January 1943, including Changes No. 1, dated 23 February 1944; and WDTB 9-731E-8, dated 18 February 1944. It also includes all pertinent information from OFSTB 700-15, dated 21 July 1942; OFSTB 700-30, dated 9 January 1943; OFSTB 700-66, dated 11 June 1943; WDTB ORD 20, dated 24 January 1944; WDTB ORD 41, dated 12 February 1944; WDTB ORD 83, dated 25 April 1944; and WDTB ORD 126, dated 19 July 1944.

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WAR DEPARTMENT
Washington 25, D. C., 15 August 1944

TM 9-731E, Carriage, Motor, 105-mm Howitzer, M7, is published for the information and guidance of all concerned.

[A.G. 300.7 (23 Dec 43)
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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION: R 9 (4); IBn 6 and 9 (4); IC 6 and 9 (2).

(For explanation of symbols, see FM 21-6.)

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PART ONE — GENERAL

Section I

INTRODUCTION

1. SCOPE.

a. These instructions are published for the information and guidance of the personnel to whom this equipment is assigned. It contains information on the operation and maintenance of the 105-mm Howitzer Motor Carriage M7, as well as descriptions of the major units and their functions in relation to the other components of this vehicle.

b. This manual has the following arrangement:

(1) Part One, General, contains description and data. It lists the tools, spare parts, and equipment carried on the vehicle. It also lists organizational special tools for the vehicle.

(2) Part Two, Operating Instructions, contains instructions for the operation of the vehicle with description and location of the controls and instruments.

(3) Part Three, Maintenance Instructions, contains information needed for the performance of the scheduled lubrication and preventive maintenance services, and instructions for maintenance operations which are the responsibility of the using organizations (first and second echelons). Stock numbers in this part were obtained from the ORD 7 (Organizational Spare Parts and Equipment List) of SNL G-128.

(4) Part Four, Armament, lists the authorized ammunition and sighting equipment, and contains the essential instructions for the operation of the 105-mm Howitzer M2A1.

(5) The appendix contains instructions for shipment and limited storage, and a list of references which includes standard nomenclature lists, technical manuals, and other publications applicable to the vehicle.

2. RECORDS.

a. Forms and records applicable for use in performing prescribed operations are listed below with brief explanations of each.

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

(1) STANDARD FORM NO. 26, DRIVER'S REPORT—ACCIDENT, MOTOR TRANSPORTATION. One copy of this form will be kept with the vehicle at all times. In case of an accident resulting in injury or property damage, it will be filled out by the driver on the spot, or as promptly as practical thereafter.

(2) WAR DEPARTMENT FORM NO. 48, DRIVER'S TRIP TICKET AND PREVENTIVE MAINTENANCE SERVICE RECORD. This form, properly executed, will be furnished to the driver when his vehicle is dispatched on nontactical missions. The driver and the official user of the vehicle will complete in detail appropriate parts of this form. These forms need not be issued for vehicles in convoy or on tactical missions. The reverse side of this form contains the driver's daily and weekly preventive maintenance service reminder schedule.

(3) W.D., A.G.O. FORM NO. 478, MWO AND MAJOR UNIT ASSEMBLY REPLACEMENT RECORD. This form will be used by all personnel completing a modification or major unit assembly (engine, transmission, transfer case, and tracks) replacement to record clearly the description of work completed, data, vehicle hours and/or mileage, and MWO number or nomenclature of unit assembly. Personnel performing the operation will initial in the column provided. Minor repairs, parts, and accessory replacements, will not be recorded.

(4) W.D., A.G.O. FORM NO. 6, DUTY ROSTER. This form, slightly modified, will be used for scheduling and maintaining a record of vehicle maintenance operations. It may be used for lubrication records.

(5) W.D., A.G.O. FORM NO. 462, PREVENTIVE MAINTENANCE SERVICE AND TECHNICAL INSPECTION WORK SHEET FOR FULL-TRACK AND TANK-LIKE WHEELED VEHICLES. This form will be used for all 50-hour (500-mile) or 100-hour (1,000-mile) services, and for technical inspections of these vehicles.

(6) W.D., O.O. FORM NO. 7353, SPOT-CHECK INSPECTION REPORT FOR ALL MOTOR VEHICLES. This form may be used by all commanding officers or their staff representatives in making spot-check inspections on all vehicles.

(7) W.D., A.G.O. FORM NO. 468, UNSATISFACTORY EQUIPMENT RECORD. This form will be used for reporting manufacturing, design, or operational defects in materiel with a view to improving and correcting such defects, and for use in recommending modifications of materiel. This form will not be used for reporting failures, isolated materiel defects, or malfunctions of materiel resulting from fair wear and tear or accidental damage, nor for the replacement, repair, or the issue of parts and equipment. It does not replace currently authorized operational or performance records.

(8) W.D., O.O. FORM NO. 7370, EXCHANGE PART OR UNIT

IDENTIFICATION TAG. This tag, properly executed, may be used when exchanging unserviceable items for like serviceable assemblies, parts, vehicles, and tools.

Section II

DESCRIPTION AND DATA

3. DESCRIPTION.

a. General. The 105-mm Howitzer Motor Carriage M7 is a gasoline-engine-powered, armored, full-track-laying vehicle. It is designed to give more protection to the crew than earlier models. The chassis is similar to Medium Tank M4.

b. Principal Armament. The principal armament of the vehicle consists of the 105-mm howitzer (fig. 1), located in the front end of the crew compartment to the driver's right and the caliber .50 machine gun in the machine gun turret on the right wall of the hull. Provisions are made for three caliber .45 submachine guns and hand grenades.

c. Crew. The vehicle crew consists of seven men: driver, chief of section, gunner, and four cannoneers.

d. Access. Access to the vehicle is gained by mounting at either side of the crew compartment. Each side has two pairs of grip bars (fig. 2) which serve as ladders to the crew compartment. The folding armor plate on each side may be kept lowered, except during tactical situations, to make access easier.

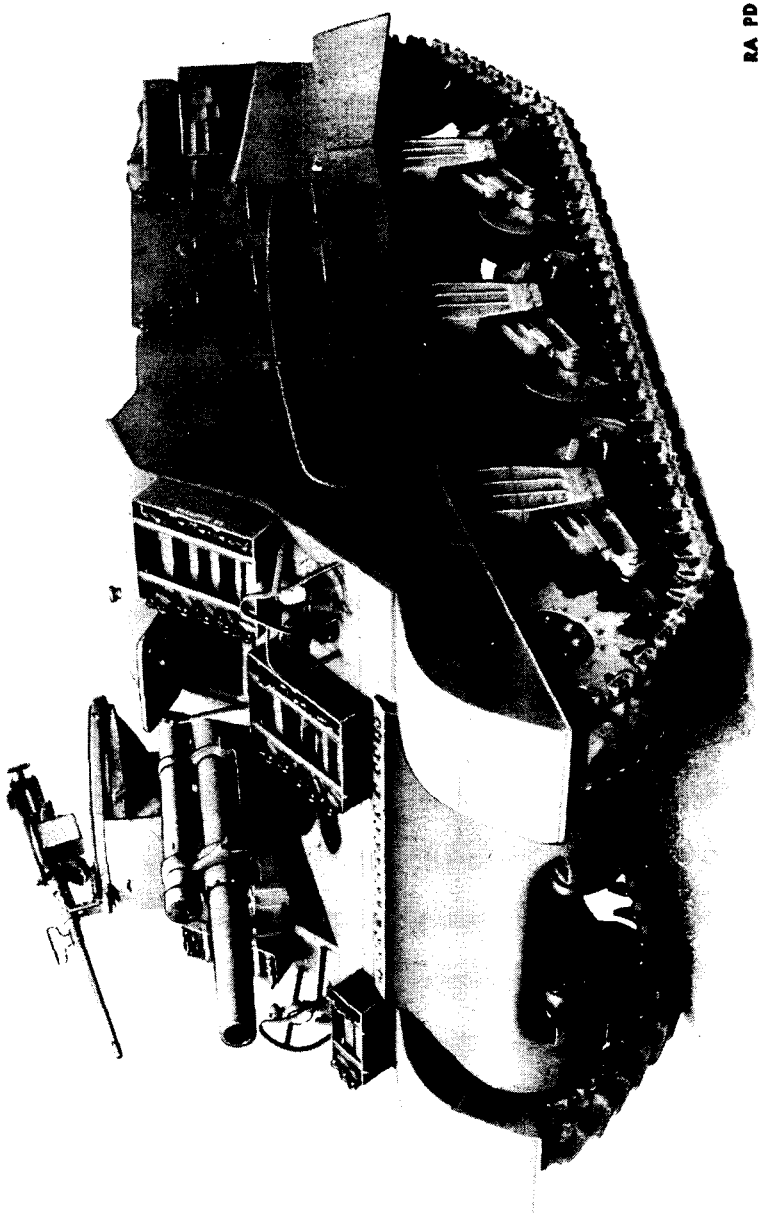
e. Direct and Indirect Vision. Both direct and indirect vision are provided for the driver of the vehicle. Direct vision is through a removable windshield. Indirect vision is through a protectoscope located on the indirect vision door.

f. Weather Protection. A fabric top is provided for the vehicle to shelter the crew in case of bad weather (fig. 4).

g. Towing Facilities. The vehicle has four towing shackles, two at the front and two at the rear. A pintle is provided at the rear below the rear engine door. The pintle is designed for a maximum drawbar pull of 10,000 pounds and is intended for towing light trailers. When the gross weight of the towed vehicle is unknown, or exceeds 10,000 pounds, use the towing shackles.

h. Power Plant. The vehicle is powered by a 400-horsepower, static, 9-cylinder, radial, aircraft-type engine. Access to the engine is provided through two engine compartment top plates (fig. 5), the rear engine doors (fig. 3), and the inspection plate located beneath

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RA PD 320942

Figure 1 — 105-mm Howitzer Motor Carriage M7 — Left Front View

DESCRIPTION AND DATA

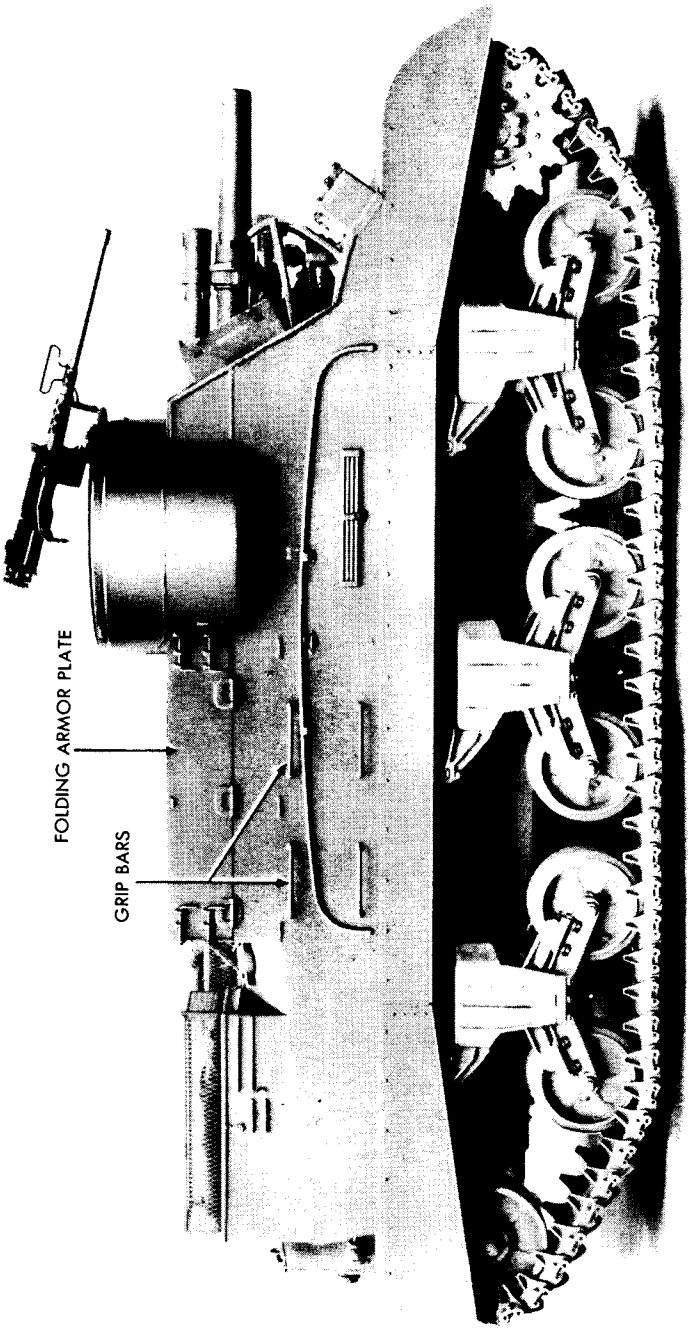


Figure 2 — 105-mm Howitzer Motor Carriage M7 — Right Side View

the engine. An air inlet shutter on the front top plate gives access to the fan compartment. The vehicle is equipped with four fuel tanks: two vertical tanks and two sponson tanks. These tanks are filled through two caps, one on each sponson to the right and left of the front top plate. The caps are protected by covers (fig. 5). Do not attempt to fill the fuel tanks above the level to which they fill rapidly. This prevents overfilling of the tanks and allows for fuel expansion.

i. **Differences Among Models.** The vehicles of late manufacture differ in some respects from vehicles of early manufacture. In those cases where these modifications affect operation on maintenance, alternate procedures are provided in this manual. The most important modifications are:

Early Models	Late Models
(1) Brakes, single-anchor type	(1) Brakes, double-anchor type
(2) Clock on instrument panel	(2) Clock removed
(3) Clutch pedal operates clutch	(3) Clutch pedal operates clutch and engine idle speed control in some vehicles
(4) Dilution valve, solenoid-operated	(4) Dilution valve removed
(5) Final drive made in three pieces	(5) Final drive made in one piece
(6) Fuel filter, screen-type	(6) Fuel filters, disk-type
(7) Fuel shut-off valves, six in vehicle	(7) Two fuel shut-off valves
(8) Generator mounted on and driven by engine	(8) Generator mounted in hull and belt-driven from propeller shaft
(9) Generator regulator located at rear of crew compartment	(9) Generator regulator located at rear of transmission
(10) Hull, no folding armor plates	(10) Hull, folding armor plates
(11) Idler wheels with spokes	(11) Idler wheels of disk type

DESCRIPTION AND DATA

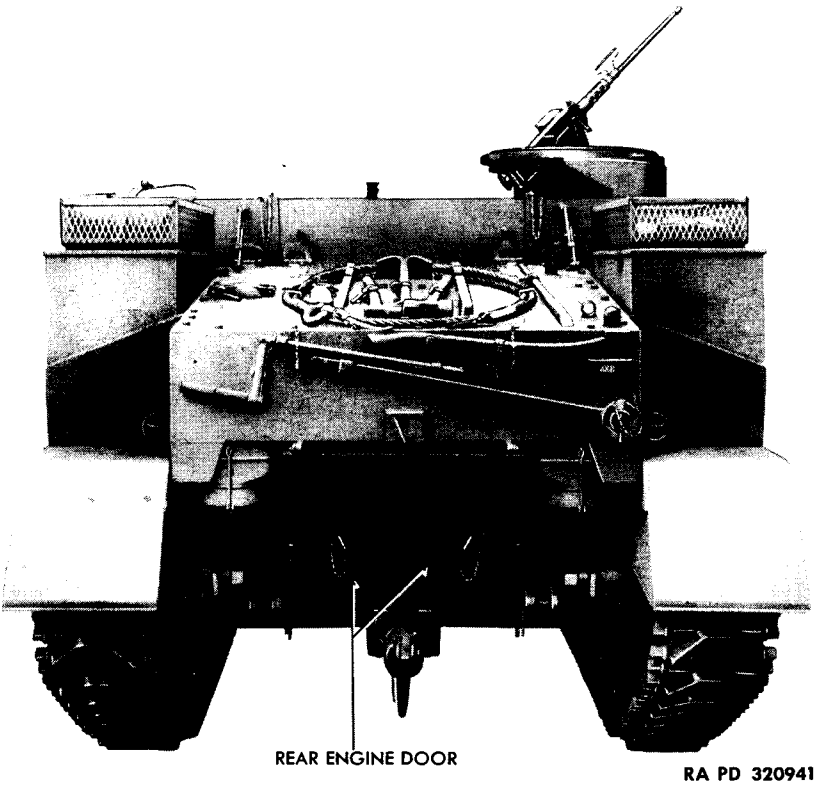
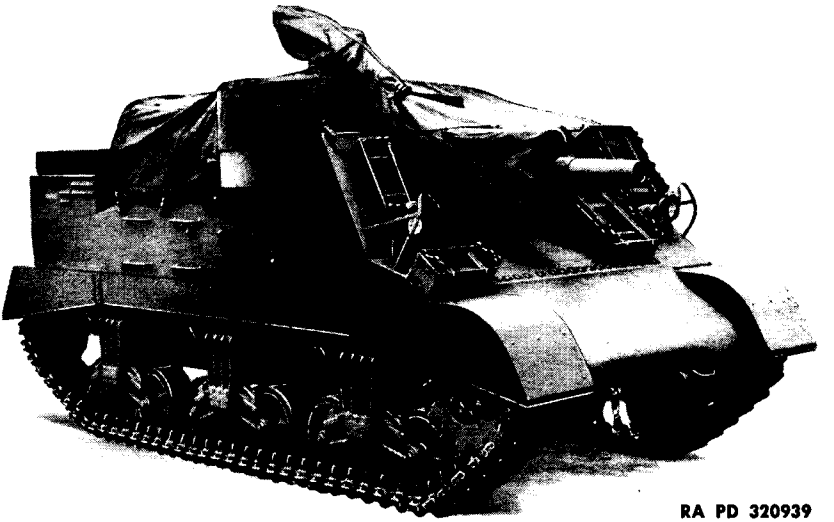


Figure 3 — 105-mm Howitzer Motor Carriage M7 — Rear View

Early Models	Late Models
(12) Instrument panel mounted on front hull wall	(12) Instrument panel mounted on left front sponson
(13) Oil supply tank on right side of engine	(13) Oil supply tank on left side of engine
(14) Parking brake, transmission type	(14) Parking brake, locking device on steering levers
(15) Sand shields not installed	(15) Sand shields installed
(16) Horn button foot-operated	(16) Horn button hand-operated
(17) Tachometer take-off at engine	(17) Tachometer take-off at input to transmission

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Figure 4 — 105-mm Howitzer Motor Carriage M7 — Top and Guns Covered

4. DATA.

a. Vehicle Specifications.

Length, over-all (approximate) ..... 222 $\frac{9}{32}$ in.
Width, over-all ..... 113 $\frac{5}{16}$ in.
Height, over-all (vehicle only) ..... 100 in.
Weight fully equipped (with counterweights, pioneer equipment, water, oil, fuel, ammunition, and crew) (approximate) ..... 52,000 lb
Track ..... Rubber
Track size:
  Width ..... 16 in.
  Length ..... 39 ft 5½ in.
Tread (center-to-center) ..... 83 in.
Track pitch ..... 6 in.
Ground clearance, vehicle ..... 17⅛ in.
Pintle height ..... 25¼ in.
Cruising range ..... 165 mi
Crew ..... 7 men (driver, chief of section, gunner, and 4 cannoneers)

b. Performance.

Maximum width of ditch vehicle will cross ..... 7 ft 6 in.
Minimum turning diameter ..... 62 ft

DESCRIPTION AND DATA

Maximum vertical obstacle vehicle will climb over (rubber tracks, without grousers) ..... 24 in.
Maximum fording depth (at slowest speed) ..... 42 in.
Towing facilities (front) ..... 2 shackles
Towing facilities (rear) ..... 2 shackles, 1 pintle
Maximum grade ascending ability (with grousers) ..... 60 pct
Maximum grade descending ability (approximate) ..... 60 pct
Maximum speed ..... 24 mph
Maximum sustained speed (on hard roads) ..... 21 mph

c. Engine.

Engine horsepower at 2400 rpm (rated) 400
Number of cylinders 9
Maximum allowable engine speed ..... 2,400 rpm
Engine governed idling speed ..... 500 rpm
Vehicle cruising speeds:
- First speed gear ..... 2 mph
- Second speed gear ..... 5 mph
- Third speed gear ..... 9 mph
- Fourth speed gear ..... 14 mph
- Fifth speed gear ..... 21 mph
- Reverse ..... 3 mph

d. Capacities.

Two right side fuel tanks ..... 88 gal
Two left side fuel tanks ..... 88 gal
Engine oiling system:
- Early vehicles ..... 36 qt
- Late vehicles ..... 52 qt

Transmission, differential, and final drive ..... 172 qt

e. Weight.

Engine shipping weight ..... 955 lb
Final drive ..... 8,800 lb

f. Communications.

Radio:
- 1 flat set M238

g. Hull Armor Thickness.

Upper front plate ..... ½ in.
Lower front plate ..... 2 to 4½ in.

Sides ..... ½ in.
Rear plates ..... ½ in.

h. Armament.

105-mm Howitzer M2A1 1
Cal. .50 Machine Gun M2HB 1
Cal. .45 Thompson Submachine Gun M1928A1 3

i. Ammunition Carried.

105-mm ..... 69 rd
Caliber .50 ..... 300 rd
Caliber .45 ..... 1,620 rd
Hand grenades 8

Section III

VEHICLE STOWAGE AND SPECIAL TOOLS

5. PURPOSE.

a. The lists in this section are for information only and must not be used as a basis for requisition.

6. ON-VEHICLE TOOLS.

a. Pioneer (fig. 5).

Quantity per Vehicle	Item Name and Stockage Number	Stowage Location
1	AX, chopping, 4-lb.	Rear plate
1	BAR, crow, 5 ft long, pinch-point	Rear deck
1	HANDLE, mattock	Rear deck
1	MATTOCK, pick M1 (without handle)	Right front fender
1	SHOVEL, short-handled	Rear deck
1	SLEDGE, blacksmith, dbl-face, 10-lb.	Rear deck

b. Vehicle.

1	BAR, cross	Left rear sponson box
1	CHISEL, cold, ¾-in.	Left rear sponson box
1	FILE, 3-sq, smooth, 6-in.	Left rear sponson box
1	FILE, hand, smooth, 8-in.	Left rear sponson box
1	FIXTURE, set, track connecting	Right rear sponson box
1	GUN, lubricating, pressure (hand-operated)	Left rear sponson box
1	HANDLE, machinist's, ball peen, 32-oz.	Left rear sponson box
1	HANDLE, combination tee, ½-in. sq-drive, 11-in.	Left rear sponson box
1	HANDLE, combination, tee, ¾-in. sq-drive, 17-in.	Left rear sponson box

VEHICLE STOWAGE AND SPECIAL TOOLS

Quantity per Vehicle	Item Name and Stockage Number	Stowage Location
1	WRENCH, engineer's, double-head, $\frac{13}{16}$-in. x $\frac{7}{8}$-in.	Left rear sponson box, in bag
1	WRENCH, engineer's, double-head, $\frac{15}{16}$-in. x 1-in.	Left rear sponson box, in bag
1	WRENCH, plug (for differential filler and drain plug), $\frac{3}{4}$-in. hex	Left rear sponson box, in bag
1	WRENCH, plug (for transmission and oil drain plug), $\frac{9}{16}$-in. hex	Left rear sponson box, in bag
1	WRENCH, safety screw, $\frac{1}{32}$-in. hex	Left rear sponson box, in bag
1	WRENCH, safety screw, $\frac{1}{8}$-in. hex	Left rear sponson box, in bag
1	WRENCH, safety screw, $\frac{3}{16}$-in. hex	Left rear sponson box, in bag
1	WRENCH, safety screw, $\frac{1}{4}$-in. hex	Left rear sponson box, in bag
1	WRENCH, safety screw, $\frac{5}{16}$-in. hex	Left rear sponson box, in bag
1	WRENCH, safety screw, $\frac{3}{8}$-in. hex	Left rear sponson box, in bag
1	WRENCH, safety screw, $\frac{5}{8}$-in. hex	Left rear sponson box, in bag
1	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, $\frac{3}{8}$-in. sq	Left rear sponson box, in bag
1	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, $\frac{7}{16}$-in. hex	Left rear sponson box, in bag
1	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, $\frac{1}{2}$-in. hex	Left rear sponson box, in bag
1	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, $\frac{9}{16}$-in. hex	Left rear sponson box, in bag
1	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, $\frac{5}{8}$-in. hex	Left rear sponson box, in bag
1	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, $\frac{3}{4}$-in. hex	Left rear sponson box, in bag
2	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, $\frac{7}{8}$-in. hex	Left rear sponson box, in bag
2	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, $\frac{15}{16}$-in. hex	Left rear sponson box, in bag
1	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, 1-in. hex	Left rear sponson box, in bag
1	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, $1\frac{1}{16}$-in. hex	Left rear sponson box, in bag
1	WRENCH, socket, $\frac{1}{2}$-in. sq-drive, $1\frac{1}{8}$-in. hex	Left rear sponson box, in bag
1	WRENCH, socket, $\frac{3}{4}$-in. sq-drive, $1\frac{1}{2}$-in. hex	Left rear sponson box, in bag
1	WRENCH, track-adjusting, 3.031-in. hex. 44$\frac{5}{8}$ in. long	Bracket on rear plate

c. Gun.

(1) 105-MM GUN.

1	Hammer, rawhide, 2-lb.	Gun tool box back of driver

(2) CAL. .50 MACHINE GUN.

1	Screwdriver, common, 3-in. blade	Gun tool drawer in turret
1	Wrench, combination, M2	Gun tool drawer in turret

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7. ON-VEHICLE EQUIPMENT.

a. Ammunition.

(1) CAL. .45.

Quantity per Vehicle	Item Name and Stockage Number	Stowage Location
1620	Cal. .45 rounds	In boxes, 18 clips per box, 30 rounds per clip. Two boxes left front, one box left rear

(2) CAL. .50.

300	Cal. .50 rounds 80% armor piercing 20% tracer	6 - 50 round belts, 5 in large box, 1 in box on machine gun

(3) 105-MM.

69	105-mm rounds	19 on left sponson, 17 on right sponson, 8 on left beneath floor, 25 on right beneath floor

(4) HAND GRENADES.

6	Smoke, W. P.	
2	Fragmentation, Mk. II, with fuze M7	

b. Communications.

1	Flag set, M238, composed of: 1—Case, CS-90 1—Flag, MC-273 (red) 1—Flag, MC-274 (orange) 1—Flag, MC-275 (green) 3—Flag staff, MC-270	Left rear sponson box
1	Panel set, consisting of: 2—Cases, CS-150 1—Panel, AL-140 1—Panel, AL-141	Left rear sponson box

c. Fire Extinguishers.

2	Extinguisher, fire, 4-lb, CO_2 (portable)	On right and left sponsons
1	Extinguisher, fire, 10-lb, CO_2 (fixed)	In bracket under crew compartment subfloor

d. Gun.

(1) CAL. .45 SUBMACHINE GUN.

3	Brush, chamber cleaning, M6	Gun tool drawer in turret
3	Brush, cleaning, cal. .45, M5	Gun tool drawer in turret
3	Case, accessories and spare parts, M1918 (w/o contents)	Gun tool drawer in turret
3	Envelope, fabric, one button, 3 x 3⅛-in.	Gun tool drawer in turret
54	Magazine, 30 rounds (clip)	3 boxes—2 on left front sponson in brackets, 1 in bracket in machine gun turret
3	Oiler, Thompson submachine gun	Gun tool drawer in turret
3	Rod, cleaning	Gun tool drawer in turret
3	Sling, gun, M1923 (webbing)	On guns
3	Thong	On guns

VEHICLE STOWAGE AND SPECIAL TOOLS

(2) CAL. .50 MACHINE GUN.

Quantity per Vehicle	Item Name and Stockage Number	Stowage Location
1	Bag, metallic belt link	Gun tool drawer in turret
4	Box, ammunition, cal. .50, M2	On shelf in machine gun turret
4	Brush, cleaning, cal. .50, M4	Gun tool drawer in turret
1	Case, cleaning rod, M15	Gun tool drawer in turret
1	Chute, metallic belt link, M1	Gun tool drawer in turret
1	Cover, gun and cradle, cal. .50	On gun cradle
1	Cover, spare barrel, M13, 45 in.	On spare barrel
1	Cover, tripod mount, machine gun, cal. .50, M1	On tripod mount
2	Envelope, spare parts, M1 w/o contents	Gun tool drawer in turret
1	Extractor, ruptured cartridge, cal. .50	Gun tool drawer in turret
1	Mount, tripod, cal. .50, M3	On rails on rear deck
1	Oiler, filling, oil buffer	Gun tool drawer in turret
1	Rod, jointed, cleaning, M7	Gun tool drawer in turret

(3) 105-MM HOWITZER.

1	Book, Artillery Gun, O.O. Form 5825	In bracket above driver
1	Brush, bore and staff complete, composed of:	
	*1—Brush, bore, M12	On staff middle
	1—Staff, end	In bracket, on rear fighting compartment wall
	1—Staff, middle	In bracket, on rear fighting compartment wall
2	Brush, gear, cleaning, M23	In gun tool box back of driver
1	Cover, bore brush, M515	On brush
1	Cover, breech, 105-mm, M212	On howitzer
1	Cover, muzzle, 105-mm, M4	On howitzer
1	Filler, oil screw	In gun tool box back of driver
1	Rammer, cleaning and unloading M5	In bracket on rear fighting compartment wall
1	Release, oil	In gun tool box back of driver
1	Roll, spare parts	In gun tool box back of driver
1	Setter, fuze, M14	In gun tool box back of driver
1	Sight, bore, 105-mm howitzer M1 complete, composed of: 1—Sight, bore, breech, RF11TB 1—Sight, bore, muzzle, RF11BD	In gun tool box back of driver
1	Oil, recoil, special (Spec. AXS-808) (In container, 1 qt type 1, class "D," Spec. 100-13)	In can
1	Table, firing and conversion	In bracket above driver
1	Target, testing (set of 4 targets in envelope)	In gun tool box back of driver
1	Wrench, fuze, M7	In gun tool box back of driver

*Brush, bore, M30 to be used when brush, bore, M12 is not available.

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e. General.

Quantity per Vehicle	Item Name and Stockage Number	Stowage Location
3	Apparatus, decontaminating, 1½-qt, M2 (Spec. 197-54-113)	1 on left gun trail, 1 in right gun shield, 1 on right gun trail
7	Bag, canvas field, O.D. M1936	4 in left rear sponson box, 3 in right rear sponson box
1	Bag, tools	In left rear sponson box
3	Belt, safety	On driver's seat, on pad seats left and right front
24	Battery (8 to be put in flashlight) (16 spares)	
2	Bow	In brackets on vehicle side walls
4	Bow, side	In brackets on vehicle side walls
1	Bucket, canvas, folding, 18-qt	In bracket in machine gun turret
1	Cable, towing, 1⅛-in.	In clips on rear deck
7	Canteen, M1910, with cup and cover M1910	On troops
1	Catalog, service parts, SNL G-128	In right rear sponson box
2	Container, water, 5-gal, A353 (Q.M.C. standard)	1 beneath right gun shield 1 beneath floor at rear
1	Cover, howitzer motor carriage, M7	On bows of vehicle or folded on rear deck
1	Crank	Cover plate above engine compartment
1	Cutter, wire	In left sponson box
1	Envelope, waterproof	
4	Flashlight (Spec. 17-197)	In bracket, left and right, front and rear
26	Grouser to match track furnished	In boxes on front of vehicle
1	Kit, first aid (24-unit) (Spec. 1553)	In bracket, left wall near front
1	Lamp, inspection	In left rear sponson box
1	Light, inspection	In left rear sponson box
4	Lamp (spare for flashlight)	
1	Lever, front door	In bracket, left gun trail
1	Lifter, protectoscope	In gun tool box back of driver
2	List, organizational spare parts and equipment, SNL G-128	In right rear sponson box
1	Lubrication Order No. 106, War Department	In bracket above driver
1	Manual, field, cal. .50 M.G. M2HB	In right rear sponson box
1	Manual, technical, 105-mm howitzer M.C. M7 (TM 9-731E)	In right rear sponson box

VEHICLE STOWAGE AND SPECIAL TOOLS

Quantity per Vehicle	Item Name and Stockage Number	Stowage Location
2	Mittens, asbestos, pr	In gun tool box back of driver
1	Net, camouflage, cotton shrimp 45-ft x 45-ft (Spec. T-1669)	Strapped to rails on rear deck
8	Oil, engine (Spec. 2-104) (In container, 1-qt, type 1) (Class "D,") (Spec. 100-13)	In cans
1	Oiler, trigger-type, 1-pt	In bracket to right of driver
2	Padlock, 1½, 2 keys	One on each rear sponson box
1	Paulin, 12-ft x 12-ft	Wrapped around bedrolls strapped
7	Roll, blanket	In baskets on sponson stowage boxes
1	Stove, cooking, M1941, consisting of: 1—Coleman military burner No. 520 with accessory cups	
1	Sheet, instructions, for compass	
1	Tape, adhesive, 4 in. wide, 15-yd roll (O.D.)	In gun tool box back of driver
1	Tape, friction, ¾ in. wide, 30-ft roll	In gun tool box back of driver
2	Tube, flexible nozzle	In right rear sponson box
1	Windshield, driver's	In box, left sponson at front
1	Wire, soft-iron, 14-gage, 10-ft	In left rear sponson box

f. Rations.

42 packages	Type "K," 2-day rations, for 7 men	In box back of driver (on floor)
84 cans	Type "C," 2-day rations, for 7 men.	In box back of driver (on floor)
2 boxes	Type "D," 1-day ration, for 7 men.	In box back of driver (on floor)

g. Sighting.

1	Bar, extension, 6-in.	In mount M21
1	Bar, extension, 12-in., M1	In gun tool box back of driver
1	Binocular, M3, complete, composed of: 1—Binocular, M3 1—Case, carrying, M17	In bracket on left front plate
1	Light, instrument, M19 (for panoramic telescope)	On panoramic telescope mount M21
1	Drum, range, zone III	In box on left side of machine gun turret
1	Drum, range, zone V	In box on left side of machine gun turret
1	Drum, range, zone VII	In box on left side of machine gun turret

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

Quantity per Vehicle	Item Name and Stockage Number	Stowage Location
1	Light, aiming post, M14, complete, composed of:	
	8—Cell, flashlight	In chest, packing
	1—Chest, packing, M14	In gun tool box back of driver
	2—Lamp, electric, 3-volt	In chest, packing
	2—Light, aiming post, M14	In chest, packing
1	Mount, elbow telescope, M42	On quadrant range M4
1	Post, aiming, M1, complete, composed of:	
	1—Cover, aiming post, M-401	On bracket on rear fighting compartment wall
	2—Post, aiming, M1	In case
4	Prism, protectoscope	In box at lower left of front plate
1	Telescope, elbow, M16	In mount, telescope, M42
1	Telescope, panoramic, M12A2	In box on center of front plate
1	Wrench, wing teat, pin face, 3/8 in. span with screwdriver blade	In box on center of front plate
1	Quadrant, range, M4	
1	Mount, telescope, M21; quadrant, gunner's, M1	In case
1	Case, carrying, gunner's quadrant, M1	In bracket in machine gun turret

8. ON-VEHICLE SPARE PARTS.

a. Gun.

(1) CAL. 45 SUBMACHINE GUN.

1	Disconnector—6D	Gun tool drawer in turret
1	Ejector—4B (M1928A1 only)	Gun tool drawer in turret
1	Ejector, assembly (M1 only)	Gun tool drawer in turret
1	Extractor—15A	Gun tool drawer in turret
1	Pin, firing—14A	Gun tool drawer in turret
1	Rocker—16D	Gun tool drawer in turret
1	Spring, disconnector—9A	Gun tool drawer in turret
1	Spring, firing pin—14C	Gun tool drawer in turret
1	Spring, magazine catch—9D	Gun tool drawer in turret
1	Spring, recoil—17C	Gun tool drawer in turret
1	Spring, rear—9B	Gun tool drawer in turret

(2) CAL. .50 MACHINE GUN.

1	Barrel, assembly	In cover, in bracket on battery case
1	Disk, buffer	Gun tool drawer in turret

VEHICLE STOWAGE AND SPECIAL TOOLS

Quantity per Vehicle	Item Name and Stockage Number	Stowage Location
1	Extension, firing pin	Gun tool drawer in turret
1	Extractor, assembly	Gun tool drawer in turret
1	Lever, cocking	Gun tool drawer in turret
1	Pin, cotter, belt feed lever pivot stud	Gun tool drawer in turret
1	Pin, cotter, cover pin	Gun tool drawer in turret
2	Pin, cotter, switch pivot	Gun tool drawer in turret
1	Pin, firing	Gun tool drawer in turret
1	Plunger, belt feed lever	Gun tool drawer in turret
1	Rod, driving spring, w/spring assembly	
	Slide, belt feed group, consisting of:	
	1—Arm, belt feed pawl	Gun tool drawer in turret
	1—Pawl, belt feed assembly	Gun tool drawer in turret
	1—Pin, belt feed pawl assembly	Gun tool drawer in turret
	1—Slide, belt feed, assembly	Gun tool drawer in turret
	1—Spring, belt feed pawl	Gun tool drawer in turret
1	Slide, sear	Gun tool drawer in turret
1	Spring, belt feed lever plunger	Gun tool drawer in turret
1	Spring, belt holding pawl	Gun tool drawer in turret
1	Spring, cover extractor	Gun tool drawer in turret
1	Spring, locking, barrel	Gun tool drawer in turret
1	Spring, sear	Gun tool drawer in turret
1	Stud, bolt	Gun tool drawer in turret
(3)	105-MM HOWITZER.	
1	Lock, firing, M13 assembly	In roll, spare parts in gun tool box back of driver
1	Pin, firing	In roll, spare parts in gun tool box back of driver
1	Spring, compression (firing)	In roll, spare parts in gun tool box back of driver

b. Vehicle.

3	Fitting, lubrication, straight, ⅛ in.	Left rear sponson box
3	Fitting, relief	Left rear sponson box
12	Connector, end	On spare track block assembly
4	Lamp, 3-cp, 24- to 28-volt	Left rear sponson box
6	Link	Assembly attached to rails, across rear of rear deck plate
2	Pin, cotter, ¼-in. x 2¼-in. (for tow shackle pin)	Left rear sponson box
2	Pin, locking (for tow shackle pin)	Left rear sponson box
12	Wedge	On spare track block assembly

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

9. SPECIAL TOOLS.

Tool	Federal Stock Number	Manufacturer's Tool Number
COMPRESSOR, suspension, volute spring	41-C-2556	MTM-M3-3
DRIFT, clutch oil sleeve, inner, installing	41-D-1540-50	MTM-M3-503
CABLE, extension, rubber covered, two conductor, standard No. 1 gage, w/plug on each end	17-C-568-530	MTM-M3-503
DRIFT, clutch spindle bearing inner, installing	41-D-1540-150	MTM-M3-502
DRIFT, clutch spindle bearing outer, installing	41-D-1540-200	MTM-M3-504
FIXTURE, removing and replacing, power train assembly	41-F-2997-220	MTM-M3-165
GAGE, thickness, 10 leaved (8 curved and 2 straight) range, 0.010 in. to 0.075 in.	41-G-412-530	MTM-M3-398
GUIDE, bogie wheel gudgeon, installing	41-G-1235-505	MTM-M3-5
LIFT, bogie wheel, medium tank	41-L-1375	MTM-M3-813
INDICATOR, piston, top dead center, dial-type	41-I-73-110	MTM-M3-237
PIN, alining, tapered, bolt holes to power train and hull, 3/8-in. point dia, 7-in. over-all length	41-P-555-600	MTM-M3-164
PIN, holding, tapered, power train assembly, 1/4-in. point dia, 7-in. over-all length	41-P-647	MTM-M3-163
PLATE, lifting clutch spindle and cover assembly	41-P-1542-200	MTM-M3-499
PULLER, idler wheel	41-P-2940-800	MTM-M3-8
PULLER, magneto gear, screw type	41-P-2941-800	MTM-M3-231
PULLER, slide-hammer type bogie gudgeon	41-P-2957-27	
SCREWDRIVER, valve clearance adjusting	41-S-1725	MTM-M3-239
SLING, battery lifting	41-S-3829-50	
SLING, engine	41-S-3832	
STAND, engine inspection	41-S-4972	STY-15036
STAND, engine transport	41-S-4942-23	STY-15040A
TOOL, idler wheel installing	41-T-3216-150	MTM-M3-9
WRENCH, box, generator attaching, 1/2-in. special	41-W-636-550	MTM-M3-506
WRENCH, box (split), single-end double-hex, flare nut, pipe and tubing, size of opening, 1 3/8 in.	41-W-637-455	RX-44

VEHICLE STOWAGE AND SPECIAL TOOLS

Tool	Federal Stock Number	Manufacturer's Tool Number
WRENCH, crowfoot, starter, attaching 9/16-in. special	41-W-871-45	MTM-M3-505
WRENCH, cylinder hold-down nut, 1/2-in. hex	41-W-871-37	MTM-M3-290
WRENCH, drain plug, final drive, differential, 3/4-in. hex	41-W-1960-236	MTM-M3-130
WRENCH, drain plug, transmission and oil tank, 9/16-in. hex	41-W-1960-175	MTM-M3-131
WRENCH, engine support nut, 1 1/4-in. hex	41-W-906-25	MTM-M3-254
WRENCH, intake pipe packing nut	41-W-1537	MTM-M3-210
WRENCH, magneto, with gage, 1/4-in.	41-W-1555	SCI-11-490
WRENCH, oil pressure relief valve body, 7/8-in. x 9/16-in. hex	41-W-636-620	MTM-M3-341
WRENCH, oil pump to crankcase rear section attaching nut, 7/16-in. hex	41-W-1577-600	MTM-M3-299
WRENCH, plug, male, 5/8-in. hex	41-W-1960	MTM-M3-10
WRENCH, set, socket, special 1-in. sq-drive, extra heavy-duty	41-W-2622	MTM-M3-16A
WRENCH, spanner, track supporting roller lock ring	41-W-3260	MTM-M3-19
WRENCH, spanner, track supporting roller retainer	41-W-3261	MTM-M3-11
WRENCH, special, cylinder base screw	41-W-3336-545	CO-32101

PART TWO — OPERATING INSTRUCTIONS

Section IV

CONTROLS AND INSTRUMENTS

10. CONTROLS.

a. Fuel Shut-off Valves (fig. 6). Two fuel shut-off controls are mounted on the right and left sides of the bulkhead in the crew compartment. These controls are connected by linkage to the fuel shut-off valves located near the bottom of the vertical fuel tanks in the engine compartment. "OFF" and "ON" positions are indicated on the valve handle flange.

b. Oil Cooler Shutter Controls (fig. 6). Two oil cooler shutter controls are mounted near the center of the bulkhead in the crew compartment. The control on the right side is connected by linkage to the transmission oil cooler shutter and the control on the left side is connected to the engine oil cooler shutter. "CLOSED," "OPEN," and three intermediate positions are indicated on the control plate.

c. Air Inlet Shutter (fig. 159). The air inlet shutter installed in the engine compartment front top plate controls the amount of air drawn into the engine compartment. The air inlet shutter control may be placed in "OPEN," "CLOSED," or *three intermediate positions.*

d. Air Outlet Shutter (fig. 158). The air outlet shutter, located at the rear of the engine compartment, controls the flow of cooling air from the engine compartment. The shutter is controlled from the outside of the vehicle above the rear engine doors. The "ON" and "OFF" positions of the shutter control are indicated on the control plate. CAUTION: *Do not operate vehicle with the air outlet shutters closed, as overheating and serious damage to the engine may result because of the restricted flow of cooling air.* Later model vehicles have a warning sign with this information stamped on it.

e. Primer Pump (fig. 7). A plunger-type primer pump is bracket-mounted to the hull to the right and in front of the driver. The pump draws fuel from the left vertical fuel tank and forces it to the primer distributor to the engine where a charge of fuel is distributed to each cylinder (except the two lower cylinders) to facilitate starting.

f. Hand Throttle (fig. 7). The push-pull type hand throttle is bracket-mounted to the final drive and is connected by a cable to an arm on the cross shaft to control the carburetor throttle opening

manually. The control button is equipped with a spring catch so that the position of the carburetor throttle opening can be maintained in a fixed position.

g. Accelerator Pedal (fig. 7). The accelerator pedal is mounted on the subfloor to the right of the driver and is connected by linkage to the cross shaft, through which the carburetor throttles are regulated to control the speed of the engine.

h. Clutch Pedal (fig. 7). The clutch pedal is mounted on the subfloor to the left of the driver, and is connected by adjustable linkage to the cross shaft, through which the engine clutch can be disengaged to disconnect the engine from the propeller shaft when shifting gears. On some vehicles, linkage connection with the accelerator allows the engine to idle slower than normal to reduce gear clashing when shifting. The clutch pedal is spring-loaded and will return to the engaged position when foot pressure is relieved. A booster spring is provided for easier operation of the clutch pedal.

i. Transmission Gearshift Lever (fig. 7). The gearshift lever is mounted on the left rear side of the transmission. It is used to change gear ratios in the transmission during operation of the vehicle. The lever is equipped with a safety latch to prevent accidental shifting into first or reverse gear. Gearshift positions are shown in a diagram (fig. 10).

j. Steering Brake Controls (fig. 7). Two hand-operated levers mounted on the subfloor are connected by linkage to shafts which operate the brake shoes in the final drive. The right lever controls the right track, and the left lever controls the left track. When one lever is pulled back the track is slowed down and the speed of the other track is increased. The vehicle can be slowed down or stopped by pulling both levers back.

k. Parking Brakes (fig. 112). The brake lock pedal, installed to the right and in front of the steering brake control levers, operates the parking brake mechanism by engaging the spring-loaded stop with the toothed sections of the two steering brake control levers.

l. Master Switch (fig. 6). A master switch is located on the left side of the bulkhead terminal box. The switch is in "OFF" position when the handle lugs are at an angle from vertical, and in "ON" position when the handle lugs are vertical.

m. Circuit Breaker Reset Switch (fig. 6). A circuit breaker is installed in the lower section of the bulkhead terminal box to protect the generator system wiring and equipment from damage caused by overloads or short circuits. The reset switch is located on the underside of the terminal box.

SECOND ECHELON PREVENTIVE MAINTENANCE

MAINTENANCE	
1,000-mi.	500-mi.
		runs smoothly at normal idling speed of 500 revolutions per minute. Throughout road test, observe whether there is any tendency of engine to stall when accelerator is released. ACCELERATION, POWER, VIBRATION, AND NOISE. Test engine for normal acceleration and pulling power in each speed range. While testing in high range, accelerate engine from low speed with wide-open throttle to top speed; listen for unusual engine noise, ping, or vibration that might indicate loose, damaged, excessively worn, or inadequately lubricated engine parts or accessories. Governed engine speed should be approximately 2,400 revolutions per minute. During road test, look for excessive smoke from exhaust or engine compartment. OIL CONSUMPTION. At completion of road test, a check should be made to see if engine has been consuming an excessive amount of oil.
10	10	**Unusual Noise (Propeller Shaft and U-joints, Final Drives, Sprockets, Idlers, Bogie Wheels, Support Rollers, and Tracks).** During road test, listen for any unusual noise from any of the above items.
11	11	**Temperatures (Transmission, Final Drive, Hubs or Sprockets, Idlers, Bogie Wheels, and Support Rollers).** After operating, feel for any abnormal temperature in any of the above units.
12	12	**Gun Elevating and Traversing Mechanism.** Place vehicle in a position where it is tilted (sidewise) about 10 degrees. Traverse and elevate howitzer through its entire range by manual control. Traverse and elevate cal. .50 machine gun through its entire range, checking both howitzer and cal. .50 machine gun for binding, excessive lash, or erratic action. Be sure both guns traveling locks are in good condition and secure.
13	13	**Leaks (Engine, Oil and Fuel).** After test run, look in engine compartment, under vehicle, and in driver's and fighting compartments, for indication of oil or fuel leaks.

MAINTENANCE		
1,000-mi.	500-mi.	
14	14	**Noise and Vibrations (Engine Mountings and Accessories).** While accelerating and decelerating engine, listen for unusual noise in engine or accessories. Notice whether there is excessive vibration that may indicate loose engine mountings, or noise that may indicate loose or inadequately lubricated clutch parts or release bearings.
15	15	**Track Tension.** Inspect for satisfactory track adjustment. There should not be more than ¾- nor less than ½-inch sag halfway between the center and rear track supporting rollers (par. 134).
		MAINTENANCE OPERATIONS
16	16	**Fuel Pump Test.** PRESSURE TEST. Disconnect the fuel line which leads from pump to carburetor, and attach a pressure gage to the outlet of the fuel pump. Start the engine and run at a speed of approximately 700 revolutions per minute. Observe the reading of the pressure gage, which should be approximately 3½ pounds (par. 62).
18	18	**Side Armor (Fenders, Guards, Sand Shields, Paint, Markings, Tow Shackles, Pintle, and Siren.** Examine vehicle for damage to side armor, fenders, sand shields, and guards. Check for broken welds. Look for rust or bright spots in paint that might cause reflections. See that all vehicle markings are legible. Examine towing shackles and pintle for good condition and secure mountings. Test horn for operation and tone.
19	19	**Bottom Armor (Inspection Plates, Drain Plugs, and Valves).** Inspect hull bottom for damage. See that inspection plates, drain plugs, and valves are in good condition and secure, and that drain valves open properly and close tightly.
20	20	**Differential and Final Drives.** Inspect housings for good condition and leakage; check lubricant level. See that all assembly and mounting bolts are secure. NOTE: *If change of lubricant is due, drain and refill with specific oil at this time* (par. 21).

SECOND ECHELON PREVENTIVE MAINTENANCE

MAINTENANCE		
1,000-mi.	500-mi.	
20		TIGHTEN. Tighten all external assembly and mounting bolts securely.
21	21	**Track (Blocks, Connectors, and Wedges).** Inspect tracks to see that these items are in good condition, correctly assembled, and secure. Pay particular attention to loose connectors, bottomed wedges, and dead blocks. Tighten wedge nuts.
21		*NOTE: *Whenever the tracks are disconnected and removed from the sprockets, support rollers, and idlers, or at each third 100-hour maintenance service, the related items 22 and 25, marked by an asterisk (*) on the Preventive Maintenance Service Work Sheet W.D., A.G.O. Form No. 462, should be inspected as described below in the asterisk-marked procedures. On the regular 50- to 100-hour maintenance services, the tracks should not be removed unless repairs are needed.* CAUTION: *Whenever tracks are removed for repair or replacement, do not reinstall tracks until the services followed by the asterisk (*) in items 22 and 25 have been completed.*
22	22	**Idler (Wheels, Arms, Eccentrics, Serration Plates, Adjustment Nuts, and Springs).** Inspect these items to see that they are in good condition, correctly assembled, secure, and that grease is not leaking excessively from wheel bearing seals. Be sure adjusting nuts and adjusting pin nut are secure. Tighten all assembly and mounting bolts and nuts securely.
22		*NOTE: *In addition to the above, at each third 100-hour maintenance service, or wherever the tracks are removed from the idlers, check the idler hub bearings for looseness or end play. Spin the idler wheels and listen for any unusual noise that might indicate damaged, excessively worn, or inadequately lubricated bearings.*
23	23	**Bogie (Levers, Arms, Links, Gudgeons, Collars and Guides, Volute Springs and Seats, Frames and Wearing Plates).** Inspect to see that these items are in good condition, correctly assembled and secure, and that gudgeons, collars and guides, and

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

MAINTENANCE		
1,000-mi.	500-mi.	
		wearing plates are not excessively worn. Note whether volute springs have taken a permanent set (two or more coils resting on seat). This condition will be considered a standard for replacement.
23		TIGHTEN. Tighten all assembly and mounting nuts or screws securely.
24	24	**Wheels (Tires, Rollers, and Skids).** Inspect these items for good condition, correct assembly and secure mounting. Pay particular attention to see that tire rubber has not separated from rims and that tires are not cut, torn or excessively worn. Inspect for excessive lubricant leaks from bearings.
24		Jack up bogie wheels and examine bearings for looseness and end play. Spin wheels and listen for any unusual noise. Tighten assembly and mounting bolts securely.
25	25	**Sprockets (Hubs, Teeth, and Nuts).** Inspect sprockets for good condition, correct assembly, and security of mounting bolts. Inspect sprocket teeth for excessive wear, and shaft flange gaskets or oil seals for leaking lubricant excessively. If sprocket teeth are excessively worn, sprocket should be replaced or reversed. Tighten assembly and mounting bolts securely.
25		*NOTE: *In addition to the above, at each 100-hour operation, or whenever the track is disconnected and removed from the sprocket, check the sprocket hub bearings for looseness and end play. After performing the above, reinstall the tracks and connect them securely.*
26	26	**Track Tension.** There should not be more than ¾-inch nor less than ½-inch sag halfway between the center and rear support rollers (par. 134). Adjust track tension to this standard and lock securely.
27	27	**Top Armor (Deck, Paint and Marking, Grilles, and Doors).** Inspect these items to see that they are in good condition and secure. See that engine compartment doors and grilles are free of trash, operate freely, and are securely mounted. Examine paint for rust spots or polished surfaces that might cause glare, and see that all vehicle markings are legible.

SECOND ECHELON PREVENTIVE MAINTENANCE

MAINTENANCE		
1,000-mi.	500-mi.	
28	28	**Caps and Gaskets (Fuel and Oil Tanks).** Observe whether these items are in good condition, whether the caps lock securely on the filler necks, and that their vents are open. Be sure covers close and fasten securely.
30	30	**Engine Removal (When Required).** Remove engine on 100-hour maintenance service, only if inspections made in items 6, 9, 13, and 14 and a check of oil consumption, indicate definite need. CAUTION: *Be sure the magnetos are grounded when removing engine.*
30		CLEAN. Clean exterior of engine and dry thoroughly, taking care to keep dry-cleaning solvent away from electrical wiring, terminal boxes, and equipment.
32		**Spark Plugs.** Remove all spark plugs and examine them for cracks or broken insulators, excessive carbon deposits, and burned electrodes. Unserviceable plugs and those having gaps in excess of 0.030 inch must be replaced, using new gaskets.
32		CLEAN AND ADJUST. Clean deposits from insulators and electrodes, and adjust plugs by bending grounded electrode. Spark plug gaps should be 0.017 to 0.019 inch (par. 59).
34	34	**Generator and Cranking Motor.** Inspect both units to see if they are in good condition and securely mounted and connected. Be sure generator drive belts and pulleys are in good condition; that pulleys are secure and properly alined, and that drive belts are adjusted to provide ½-inch finger-pressure deflection.
34		SERVE. Remove generator and cranking motor commutator inspection covers, and examine commutators for good condition. See that brushes are free in brush holders, clean, and not excessively worn; that brush connections are secure, and that wires are not broken or chafing. Clean commutator end of generator and cranking motor by blowing out with compressed air. Tighten cranking motor and generator mounting bolts securely.
37	37	**Magnetos.** Inspect magnetos for good condition and security of mounting, and note whether there

MAINTENANCE		
1,000-mi.	500-mi.	
		is evidence of oil leaks at mounting pad gaskets. Remove breaker point inspection covers to see that points are not pitted, are clean, and well alined with mating surfaces, and are engaging squarely.
37		ADJUST. Adjust magneto breaker point gaps to 0.012 inch on Scintilla magnetos and 0.009 inch on Bosch magnetos (par. 54 and par. 55).
67		**Ignition Timing.** Check and set ignition timing (par. 56).
38	38	**Ignition Wiring and Conduits.** Inspect these items for good condition, cleanliness, correct assembly, tight connections, security of mountings, and for chafing against other engine parts. Clean all exposed ignition wiring with a dry cloth. See that all radio shieldings are in good condition, and that wiring harness coupling rings and nuts are tight. NOTE: *Do not disturb connections unless they are actually loose.*
43	43	**Air Cleaners (Carburetor).** Inspect air cleaner parts to see if they are in good condition. Clean the reservoirs and elements in dry-cleaning solvent and drain. Fill reservoirs to correct level with used or new engine oil. Reassemble cleaners, making certain all gaskets are in good condition and in place. Give special attention when mounting, to see that cleaners are pressed firmly in place against air horn seals, and that cleaners and connections are securely fastened.
44	44	**Carburetor (Throttle, Linkage, Governor, and Primer).** Inspect these units for good condition, correct assembly, and security of mounting. See that carburetors do not leak, that governor linkage is not excessively worn and operates freely. See that governor is properly sealed. Make sure that lines of priming system are in good condition, secure, and not leaking.
45	45	**Manifolds.** Inspect to see that all manifolds, manifold gaskets, and connections are securely fastened, correctly assembled, and not leaking.

SECOND ECHELON PREVENTIVE MAINTENANCE

MAINTENANCE		
1,000-mi.	500-mi.	
45		TIGHTEN. Tighten all loose assembly and flange nuts.
46	46	**Cylinders.** Clean dirt and grease accumulations from cylinder cooling fins, and inspect them to see if they are in good condition. Look for indications of oil or compression leaks.
47	47	**Engine (Cowling, Air Deflectors, Flywheel, Fan and Guard, Steady Bar, and Support Beam).** Inspect these units to see that they are in good condition, correctly assembled, and securely mounted.
47		TIGHTEN. Tighten all accessible mounting and assembly nuts and screws securely. NOTE: *If engine has been removed for repair, or replacement, tighten bracket to hull nuts before reinstalling engine.*
48	48	**Clutch Assembly.** On engines that are removed only, disassemble clutch, clean parts thoroughly, and inspect for excessive wear or damage. If any part is unserviceable, replace entire clutch assembly or report condition to higher echelon.
51	51	**Engine Compartment (Bulkhead and Control Linkage).** Check to see that engine compartment, including bulkhead, is in good condition and clean, and that control linkage in engine compartment is in good condition and securely connected and mounted.
52	52	**Engine Oil (Tank, Cooler, Lines, and Fittings).** Observe if these units are in good condition, correctly assembled, and secure. Check oil level in supply tank, noting if vent toggle operates properly. If an oil change is due or condition of oil warrants, drain tank and refill according to Lubrication Order, paragraph 21.
52		TIGHTEN. Tighten tank mountings and line connections carefully and securely.
52		SERVE. Drain oil from supply tank (par. 71), flush tank, and refill to proper level with specified oil. Clean engine oil cooler air passages. Clean oil tank breather element in dry-cleaning solvent, dry, oil lightly, and reinstall securely.

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

MAINTENANCE		
1,000-mi.	500-mi.	
53	53	**Fuel (Tanks, Vents, Lines and Pump).** Inspect to see that these items (where visible), are in good condition, correctly assembled, securely mounted, and not leaking.
54	54	**Engine Oil Filter.** Remove filter element from housing and clean out all solids collected in filter sump. If element is serviceable, reinstall and test operation of filter (par. 73).
55	55	**Fuel Filters.** With hull bottom inspection plate removed, inspect fuel filter mounting flanges, lines, and connections to be sure they are in good condition, secure, and not leaking.
56	56	**Transmission Oil Cooler.** Inspect core and lines of cooler to see that they are in good condition, secure, and not leaking. Clean out insects and trash from in and around core air passage.
57	57	**Exhaust Pipes.** Inspect to see that these items are in good condition and securely assembled and mounted.
57		TIGHTEN. Tighten all mounting bolts and connections securely.
58	58	**Engine Mountings.** Observe all accessible mountings and bond straps to see that they are in good condition and secure.
58		TIGHTEN. Tighten all mounting bolts securely. When engine is removed, tighten all engine support assembly bolts.
59	59	**Clutch Release (Yoke Bearings, Linkage and Mountings).** Inspect these units to see that they are in good condition, correctly assembled, secure, and not excessively worn. Observe if bearings are adequately lubricated, and if there are flat spots on outside diameters.
59		TIGHTEN. Tighten all accessible assembly and mounting bolts and screws. When engine is removed, this service should be performed before the engine is reinstalled.

SECOND ECHELON PREVENTIVE MAINTENANCE

MAINTENANCE		
1,000-mi.	500-mi.	
60	60	**Fire Extinguisher System (Tanks, Valves, Lines, Nozzles, and Mountings).** Inspect applicable items of both fixed and portable fire extinguishers. See that all tanks are full, that fixed nozzles are properly aimed, and portable extinguishers are securely fastened.
61		**Engine Installation (Mountings, Lines and Fittings, Wiring, Control Linkage, and Oil Supply).** If engine was removed for repair or replacement, reinstall at this time (par. 52). Tighten mountings securely, and connect all fuel and oil lines and control linkage. Be sure oil supply is adequate.
63	63	**Batteries (Cables, Hold-downs, Carrier, and Gravity).** Inspect battery cases for cracks and leaks. Clean top of batteries and inspect terminals, bolts, posts, straps, and hold-downs to see that they are in good condition. Test specific gravity and voltage, and record on space provided on back of Work Sheet W.D., A.G.O. Form No. 462. Gravity readings below 1.225 indicate batteries need recharging or replacement.
63		Perform high rate discharge test according to instructions for a condition test which accompanies test instrument. Cell variation should not be more than 30 percent. NOTE: *Specific gravity must be above 1.225 to make test.*
63		CLEAN. Clean batteries and carrier; repaint carrier if corroded. Clean cables, terminals, bolts, and posts; grease lightly. Inspect bolts and nuts to see that they are in good condition. Tighten terminals and hold-downs carefully to avoid damage to battery.
63	63	SERVE. Add clean water (distilled water if available) to bring electrolyte 3/8 inch above plates.
64	64	**Accelerator (Linkage).** Examine accelerator and connecting linkage to see that it is in good condition, opens throttle fully, is securely connected, and operates freely. NOTE: *Open fuel valves and close master switch at this time.*

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

MAINTENANCE		
1,000-mi.	500-mi.	
65	65	**Cranking Motor (Primer and Instruments).** Start engine to see if primer operation and action of cranking motor is satisfactory. Note particularly whether cranking motor drive engages and operates properly without unusual noise, whether it has adequate cranking speed, and whether engine starts readily. As engine starts, see that all instruments operate properly and, particularly, that oil pressure and ammeter indications are satisfactory.
66	66	**Leaks (Engine Oil and Fuel).** With engine running and fuel and oil systems under normal pressure, look for indications of leaks at tank, lines, and connections.
68	68	**Regulator Unit (Connections).** Inspect unit for good condition, and see that all connections and mountings are secure. Be sure radio noise suppression filters are in good condition and securely mounted and connected.
69	69	**Engine Idle.** Adjust idle stop screw to idle engine smoothly at 500 revolutions per minute (see paragraph 61 **b** for proper procedures).
71	71	**Crew Compartment (Paint, Seats, Safety Straps, Crash Pads, Stowage, Ammunition Boxes, Clips, and Racks).** Inspect to see that these items are in good condition and securely assembled and mounted. See that crew compartment is clean, that paint is in satisfactory condition, and that adjusting mechanism of seats operates properly and is adequately lubricated. Pay particular attention to see that all dividers and shell pads are present and properly installed in ammunition boxes and racks, and that clips have sufficient tension to hold shells securely.
73	73	**Protectoscope and Telescope.** Examine these items to see that they are in good condition, clean, and secure in holders. Make sure that holders are securely mounted, and locking devices are free and not excessively worn. See that spares are present, in good condition, and properly stowed.

SECOND ECHELON PREVENTIVE MAINTENANCE

MAINTENANCE		
1,000-mi.	500-mi.	
74	74	**Clutch Pedal (Free Travel, Bearing Clearance).** Inspect clutch pedal, linkage, and booster unit to see that they are in good condition, correctly assembled, and secure. Adjust pedal to provide approximately 1¾-inches free travel and ⅛-inch clearance between the face of the release bearing and the shoes, with clutch engaged (par. 112 b).
75	75	**Brakes (Steering, Parking Levers, Latches and Linkage).** Pull back on both steering brake levers and observe whether they meet resistance slightly before the vertical position. Apply the brakes with parking brake latch "ON," and observe whether levers remain in the applied position. Examine linkage connections, ratchets, and pawls for security and good condition.
75		TIGHTEN. Tighten all assembly and mounting nuts and screws securely.
77	77	**Differential and Final Drives (Breather, Seals, Vent).** Inspect accessible parts of these units to see that they are in good condition, that all assembly and mounting nuts or screws are secure, and that there are no leaks at seals or gaskets.
77		CLEAN AND TIGHTEN. Remove differential breather, wash element in dry-cleaning solvent, dry, oil lightly, and reinstall securely. Tighten all external assembly and mounting nuts and screws securely.
78		**Transmission (Breather, Seals, Vent).** Examine accessible parts of transmission to see that these items are in good condition, that all mounting and assembly bolts or cap screws are secure, and that there are no leaks. Inspect breathers to see that they are in good condition, secure, and not clogged.
78		CLEAN AND TIGHTEN. Remove differential breather, wash element in dry-cleaning solvent, dry, oil lightly, and reinstall securely. Tighten all external assembly and mounting nuts and screws securely.
80	80	**Transmission (Controls and Linkage).** Inspect to see that transmission control lever operates properly, is in good condition, correctly assembled, securely connected, and not excessively worn.

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

MAINTENANCE	
1,000-mi.	500-mi.
81	81	**Propeller Shaft (U-joints, Alinement, and Flanges).** Inspect propeller shaft to see that it is in good condition, that it is correctly and securely assembled and mounted, and that universal joints are properly alined and not excessively worn.
81		TIGHTEN. Tighten universal joint assembly and companion flange bolts securely.
85	85	**Lamps and Switches (Head, Tail, Blackout, and Internal).** Test to see that switches and lamps operate properly. Inspect all lights for good condition, security, for broken lenses or discolored reflectors.
86	86	**Wiring (Terminal Boxes, Circuit Breakers).** Inspect to see that all exposed wiring and conduits, and terminal boxes, are securely connected and supported, and clean. Be sure all circuit breakers and buttons operate properly, and that all radio noise suppression bond straps or clips on wiring, boxes, and instrument panel are clean and securely connected.
88	88	**Radio Bonding (Suppressors, Filters, Condensers, and Shielding).** See that all units not covered in the foregoing specific procedures are in good condition, and securely mounted and connected. Be sure all additional noise suppression bond straps and internal-external toothed washers listed in paragraph 156 **b** (4), are inspected for looseness or damage, and see that contact surfaces are clean. **NOTE:** *If objectionable radio noise from vehicle has been reported, make tests in accordance with paragraph 36. If cleaning and tightening of mountings and connections, and replacement of defective radio noise suppression units does not eliminate the trouble, the radio operator will report the condition to the designated individual in authority.*
		ARMAMENT
126	126	**Howitzer and Cal. .50 Machine Gun.** Inspect to see that howitzer elevating and traversing mechanism operates properly without play or lost motion. See that cal. .50 machine gun rotates through its entire

SECOND ECHELON PREVENTIVE MAINTENANCE

MAINTENANCE		
1,000-mi.	500-mi.	
		360-degree range, and elevates and depresses properly. Be sure traveling locks for both howitzer and cal. .50 machine gun lock securely in traveling position.
126		TIGHTEN. Tighten all howitzer and machine gun mounting bolts and cap screws securely.
129	129	**Spare Gun Barrels and Parts.** See that all spare gun barrels and parts listed in paragraph 8, are in good condition, and properly covered and stowed.
		TOOLS AND EQUIPMENT
130	130	**Tools (Vehicle and Pioneer).** Check standard vehicle and Pioneer tools against stowage lists (pars. 6 and 7) to see that they are present, in good condition, and properly stowed or mounted. Any tools mounted on outside of vehicle, having bright or polished surfaces, should be painted or otherwise treated to prevent glare or reflections. Tools with cutting edges should be sharp and edges protected.
131	131	**Equipment.** Check special equipment items against vehicle stowage list (par. 9) to see if they are all present, in serviceable condition, and properly stowed or mounted.
132	132	**Spare Grousers and Track Blocks.** Inspect to see if these items are all present, in good condition, and properly stowed or mounted.
133	133	**Spare Oil Supply (Recoil and Engine).** Check to see that supply of listed spare oil is present and properly stowed. This supply should be maintained at all times.
134	134	**Decontaminator.** Examine to see that decontaminator is in good condition, secure, and fully charged. Make latter check by removing filler plug.
135	135	**Fire Extinguishers (Portable).** Inspect to see that extinguishers are fully charged, in good condition, securely mounted, and that seal on valve head is intact. Replace with a fully charged extinguisher if weight is not up to specifications (par. 144 c).

MAINTENANCE		
1,000-mi.	500-mi.	
136	136	**Publications and Form No. 26.** Check to see whether vehicle manuals, Lubrication Order, Accident-Report Form No. 26, and MWO and Major Unit Assembly Replacement Record (W.D., A.G.O. Form 478) are present, legible, and properly stowed.
137	137	**Vehicle Lubrication.** If due, lubricate in accordance with Lubrication Order, paragraph 21, and current lubrication directives, using only clean lubricant and omitting items that have had special lubrication during this service. Replace damaged or missing fittings, vents, flexible lines, or plugs.
138	138	**Modifications (Work Orders Completed).** Inspect vehicle to determine that all Modification Work Orders have been properly completed, and entered on W.D., A.G.O. Form 478. Enter any replacement of major unit assembly made at time of this service.
139	139	**Final Road Test.** Make a final road test, rechecking items 2 to 15, inclusive. Recheck transmission and differential to see that lubricant is at correct level, and that there are no leaks. Confine this road test to the minimum distance necessary to make satisfactory observations. While testing vehicle, operate it in a normal manner. NOTE: *Correct any deficiencies found during final road test.*

Section XII

TROUBLE SHOOTING

31. GENERAL.

a. This section contains trouble shooting information and tests which can be made to help determine the causes of some of the troubles that may develop in vehicles used under average climatic conditions (above 32° F). Each symptom of trouble given under the individual unit or system is followed by a list of possible causes of the trouble. The tests necessary to determine which one of the possible causes is responsible for the trouble are explained after each possible cause.

TROUBLE SHOOTING

32. ENGINE.

a. Engine Will Not Turn.

(1) HYDROSTATIC LOCK OR SEIZURE. Remove rear spark plugs from the two lower cylinders and attempt to turn engine with hand crank to check for excess fuel or oil in combustion chambers. If engine turns, lock will be relieved. If engine does not turn, seizure due to internal damage is indicated; notify higher authority.

(2) CRANKING MOTOR INOPERATIVE. Refer to paragraph 33 **a** where this item is covered in starting system trouble shooting.

(3) INCORRECT OIL VISCOSITY. Drain and refill with proper grade of oil (pars. 21 and 70).

b. Engine Turns But Will Not Start.

(1) INOPERATIVE FUEL SYSTEM. Open fuel valves, remove outlet line at fuel pump; with ignition switch off, turn engine with cranking motor. If free flow of fuel is not evident, fuel is not reaching carburetor (par. 63).

(2) INOPERATIVE IGNITION SYSTEM. Turn on magneto switch (also booster switch with Scintilla magneto). Remove a cable from a spark plug, hold cable terminal ¼ inch from cylinder casting, and crank the engine. If a spark does not jump the ¼-inch gap, the ignition is inadequate (sec. XV).

(3) SLOW CRANKING SPEED. Refer to paragraph 33 **c** for trouble shooting on slow cranking speed.

c. Engine Does Not Develop Full Power.

(1) IMPROPER IGNITION. Refer to ignition system trouble shooting in paragraph 34.

(2) OIL TEMPERATURE TOO HIGH.

(a) Defective Thermostat in Oil By-pass Valve. A defective thermostat by-pass valve located in the engine compartment above the oil supply tank may stop the oil circulation to the oil cooler, thereby causing oil temperature to run too high. Disconnect one end of the by-pass valve to oil cooler pipe and note circulation. Little or no circulation indicates a defective thermostat in the by-pass valve. Replace thermostat to correct.

(b) Clogged Oil Cooler. A clogged oil cooler will cause oil heating. Clean the oil cooler by removing and cleaning interior oil passages with steam, or flush with dry-cleaning solvent. Blow out the fins and air passages with compressed air.

(3) IMPROPER VALVE ADJUSTMENT. Check clearance and adjust if necessary (par. 50).

(4) USE OF IMPROPER TYPE OF FUEL. Use proper fuel.

(5) PREIGNITION. If the proper octane fuel is being used and the ignition system is functioning satisfactorily, spark plugs of improper heat range may be a cause of trouble (par. 59); otherwise, internal engine troubles would be indicated. Notify higher authority.

(6) CLOGGED FUEL STRAINER IN CARBURETOR. Remove the carburetor fuel strainer as indicated in paragraph 61 **d**. Clean the strainer with dry-cleaning solvent, and then blow out with compressed air. Install cleaned strainer.

(7) AIR LEAKS AT CARBURETOR OR MANIFOLD FLANGES. With engine running at 800 revolutions per minute, apply a small amount of oil at carburetor gaskets and manifold flanges. If oil is sucked in, there is evidence of a leak. Notify higher authority.

(8) LOW ENGINE COMPRESSION OR IMPROPER VALVE TIMING. If engine does not develop full power with fuel reaching the combustion chambers, adequate ignition and sufficient oil in the engine lubrication system, low compression, or improper valve timing would be indicated. Notify higher authority.

(9) INCORRECT GOVERNOR SETTING. Disconnect governor linkage at the carburetor and check for sprung linkage or stuck throttle. If the throttle and linkage operate freely, connect linkage, start engine, and accelerate. If speed of 2,400 revolutions per minute is reached (no load), governor is controlling engine speed satisfactorily. If, under load, governor throttle is not wide open at 2,250 revolutions per minute, readjust or replace governor (par. 69).

d. Engine Misfires.

(1) FAULTY IGNITION SYSTEM. Refer to ignition system trouble shooting in paragraph 34.

(2) LOW ENGINE COMPRESSION. Refer to subparagraph **c** (8) above for correction.

(3) INCORRECT CARBURETOR ADJUSTMENT. A weak fuel mixture causes misfiring and lack of power. Adjust the carburetor as indicated in paragraph 61 **b** and **c**.

(4) CLOGGED FUEL TANK CAP VENTS. Open vents or replace cap.

(5) RESTRICTED FUEL FLOW. A clogged carburetor fuel strainer will restrict the fuel flow. Remove strainer as indicated in paragraph 61 **d**. Clean strainer with dry-cleaning solvent and then blow out with compressed air. Install cleaned strainer.

(6) WATER IN FUEL. Remove the two drain plugs at bottom of carburetor, and inspect for water.

e. Excessive Oil Consumption.

(1) OIL VISCOSITY TOO LOW.. Drain and refill with proper grade of oil as indicated in paragraphs 21 and 70 **d**.

(2) EXTERNAL OIL LEAKS. Inspect for external oil leakage at oil line connections.

(3) OIL SEAL RINGS OR PISTON RINGS DAMAGED. Notify higher authority.

f. Engine Will Not Stop.

(1) DEFECTIVE MAGNETO SWITCH, SWITCH GROUND WIRE BROKEN, GROUND WIRE FROM MAGNETOS TO SWITCH BROKEN. The correction for this trouble is indicated in paragraph 34 **b** (1).

(2) THROTTLE NOT FULLY CLOSED. Close throttle.

(3) OVERHEATED COMBUSTION CHAMBERS. Check oil temperature gage for evidence of high oil temperature. Determine if all cooling surfaces of the engine are free of dirt and oil. Remove obstructions from air intake grille and engine oil cooler. Test for clogging in oil cooler (par. 75 **b**).

33. STARTING SYSTEM.

a. Cranking Motor Will Not Operate.

(1) MASTER SWITCH NOT ON. Turn switch on.

(2) BATTERIES RUN DOWN. Close master switch. Test battery with battery testing equipment. If this test indicates that the batteries will not retain a charge, replace the batteries (par. 92 **b** and **c**). If batteries test satisfactorily, clean and tighten all battery connections.

(3) MASTER SWITCH INOPERATIVE. Turn on all lights. Depress starting switch. Under this test, the lights will normally dim somewhat; if they dim excessively, check master switch with a voltage test, using low voltage circuit tester. Depress starting switch. If voltmeter reads more than 0.5 volt, indicating high resistance in the switch, and the batteries test satisfactorily (step (2) above), replace the switch (par. 93 **d** (3) and **e** (8)).

(4) CRANKING MOTOR SWITCH INOPERATIVE OR FAULTY WIRING. Turn on panel lights. Lighting up indicates that current is reaching the instrument panel. Inspect the lower left conduit on back of instrument box to see that it is properly connected and tightened to the receptacle. If the conduit connections appear satisfactory, remove the mounting screws from face of instrument panel, and pull the panel out to give access to the switch assembly and wiring. Inspect wiring to switch for loose connections, and test switch with low voltage circuit tester. Make first test ahead of cranking motor switch to check for current at the switch, and second test from wire No. 18 (connected to the terminal marked "START" on the back of the switch) to ground. If current is not indicated when switch is turned

on for starting, replace the switch assembly (par. 93). Make test for No. 18 wire by checking for current supply with low voltage testing equipment at No. 18 wire terminal on cranking motor solenoid. Current at this point indicates the circuit complete to this point.

(5) CRANKING MOTOR SOLENOID INOPERATIVE. Check for current at No. 18 wire solenoid terminal with cranking motor switch turned on (use low voltage testing equipment). Presence of current indicates circuit complete to this point. If no sound is heard from the solenoid as the cranking motor switch is turned on, it indicates the solenoid is not operating. Replace solenoid (par. 85).

(6) CRANKING MOTOR INOPERATIVE. Inspect cranking motor cable and battery cable connections on the solenoid. Turn on cranking motor switch. If solenoid operates, check for current supply on battery cable terminal and also at cranking motor cable terminal. Use low voltage testing equipment. If tests indicate circuits are complete and cranking motor does not function when cranking motor switch is turned on, replace cranking motor (par. 84).

b. Cranking Motor Operates and Engages Flywheel But Will Not Turn Engine.

(1) TRANSMISSION IN GEAR. Shift to neutral.

(2) HYDROSTATIC LOCK OR SEIZURE. The correction for this trouble is shown in paragraph 12 **c** (1).

(3) BATTERIES RUN DOWN. The battery tests are indicated in paragraph 92 **a**. If battery tests indicate low charge, replace with a fully charged battery as indicated in paragraph 92 **b** and **c**.

(4) BENDIX CLUTCH DAMAGED OR STUCK. Replace cranking motor as shown in paragraph 84.

(5) INCORRECT ENGINE OIL VISCOSITY. Drain and refill with proper grade of oil as indicated in paragraphs 21 and 70.

c. Slow Cranking Speed.

(1) HIGH ELECTRICAL RESISTANCE, LOOSE OR CORRODED TERMINALS, WRONG SIZE CABLES OR WIRE, FAULTY STARTER OR SWITCHES. Refer to subparagraph **a** (1) through (6) above for correction of these troubles.

(2) ENGINE OIL TOO HEAVY. Use proper grade of oil as indicated in paragraphs 21 and 70.

(3) CRANKING MOTOR WORN OUT (EXCESSIVELY NOISY). Replace cranking motor (par. 84).

(4) WEAK BATTERY. Test the battery with battery testing equipment; if low charge is indicated, the battery must be replaced with one that is fully charged (par. 92 **b** and **c**).

TROUBLE SHOOTING

34. IGNITION SYSTEM.

a. Booster Does Not Function (Scintilla Magneto).

(1) FAULTY BOOSTER COIL. Turn on master switch and instrument panel light switch. Push accessory circuit breaker reset button to make sure the circuit is complete. If the panel lights do not burn, test batteries and connections (par. 92) and make necessary corrections. If the panel lights burn, indicating that there is current to the instrument panel, depress the booster switch and listen for a buzzing sound produced by the booster coil. If no sound is heard, disconnect the low tension lead from the coil and test with low voltage testing equipment to ground (hull). If a reading is obtained, the trouble is in the booster coil. If buzzing sound is heard and engine will not start, disconnect high tension lead from magneto and hold terminal close to engine with booster switch depressed. If a good spark is produced, depress starting switch. If spark becomes very weak while engine is being cranked, the batteries are low or the cranking motor circuit has high resistance (loose connections or corroded terminals). If a good spark is obtained during the test and engine will not start, disconnect the spark plug cable from No. 1 cylinder rear plug, hold the cable terminal approximately ¼ inch from ground on engine, crank the engine, and observe the spark. If no spark is obtained, replace magneto.

(2) SHORTED OR GROUNDED BOOSTER CIRCUIT (INSTRUMENT PANEL TO BOOSTER COIL. If no reading is obtained on low voltage circuit tester when testing the primary circuit at the coil (step (1) above), repeat test from booster circuit terminal in bulkhead terminal box. If a reading is obtained at that point, the trouble is in the wire or connections from terminal box to booster coil. Tighten all connections or replace the coil wire. Fasten a new wire to the old one, pull new wire into conduit as old one is drawn out. If no reading is obtained, separate connection on small flexible conduit behind instrument panel. Take a low voltage test reading from terminal "A" to ground. If a reading of 24 volts is obtained at this point, the trouble is in the wire from connection to bulkhead terminal box, or loose connection in connecting plug.

(3) FAULTY BOOSTER SWITCH AND CIRCUITS IN INSTRUMENT PANEL. Separate connector on small conduit behind instrument panel leading to rear terminal box. Connect a test voltmeter between the terminal marked "A" in the female part of the connector plug and ground (hull). If the panel lights burn, indicating that battery current is reaching the instrument panel, the test voltmeter should show a reading when booster switch is depressed. If no reading is obtained, trouble is in booster switch.

b. Improper Ignition (Bosch or Scintilla Magneto).

(1) MAGNETO SWITCH OR WIRING FAULTY. If engine runs unevenly, there may be an intermittent ground in the magneto switch or wiring. Run the engine on first one magneto and then the other to determine which circuit is at fault; then disconnect the faulty circuit in the bulkhead terminal box (fig. 73). If trouble is eliminated, connect a test ammeter or light between wire leading to magneto switch in panel and No. 13 terminal in the other section of terminal box to supply voltage to the circuit. Move the magneto switch handle slightly while it is set on the faulty magneto circuit, and observe the light or meter. If an intermittent reading is obtained, indicating that the switch is at fault, replace the magneto switch. If engine will not stop when switch is in an "OFF" position, separate connector on small conduit behind instrument panel and ground the terminals marked "B" and "C" to shell of connector. If engine stops, trouble is in magneto switch or loose connections in the connector. If engine does not stop with these connections grounded, trouble is in the wiring. Ground magneto by pressing emergency stop button on bulkhead terminal box to stop engine, and notify higher authority. If engine does not stop when emergency stop button is pressed, it indicates emergency stop switch or wire between bulkhead terminal box and the magnetos is at fault. To determine which one is at fault, ground wire leading to magneto against case of bulkhead terminal box. If engine stops, the fault is in the switch. If it continues to run, the wiring is defective.

(2) FAULTY MAGNETO. If no change in engine operation is noticed after disconnecting the magneto ground wires in bulkhead terminal box (step (1) above), connect the wires and run engine on one magneto at a time. If speed of engine drops off 300 revolutions per minute or more, and spark plugs are operating properly (step (3) below), trouble is in magneto. Check magneto timing or replace magneto (pars. 54 c (3) and 55 c (2)).

(3) SPARK PLUGS FAULTY. Uneven operation at idle speed, misfiring at high speed, or loss of power may be caused by faulty spark plugs. If no appreciable difference in speed of engine is noticed when running on first one magneto and then on the other (step (1) above), remove and inspect spark plugs. Replace with new plugs if faulty. If a definite drop-off in speed of engine is noticeable when switching from one magneto to the other (step (1) above), remove spark plug cable from the most accessible spark plug, hold cable ¼ inch from cylinder, and observe spark. If a good spark is obtained, inspect for faulty spark plugs that are operating on the magneto circuit being tested (rear plugs operate on right magneto and front plugs operate on left magneto).

TROUBLE SHOOTING

35. BATTERIES AND GENERATING SYSTEM.

a. Batteries Run Down.

(1) GENERATOR CIRCUIT BREAKER KICKED OUT. Reset generator circuit breaker on bulkhead terminal box.

(2) FAULTY BATTERIES. Test batteries as indicated in paragraph 92 **a** and if found to be faulty, replace with a fully charged battery (par. 92 **b** and **c**).

(3) EXCESSIVE USE OF ELECTRICAL ACCESSORIES WHEN GENERATOR IS NOT OPERATING. Replace batteries as indicated in paragraph 92 **b** and **c**.

(4) SWITCHES LEFT ON WHEN NOT IN USE. Turn switches off when not in use.

(5) GROUNDED OR SHORT CIRCUITS. Test as follows:

(a) Connect Battery for Test. Remove discharged batteries (par. 92). Place two fully charged batteries in the battery box, and connect the ground cable to the negative battery post. Make tests (steps (*b*) and (*c*) below) with the two 12-volt batteries.

(b) Flash Test. With all switches turned off, touch the terminal of 24-volt cable to positive post of battery, and watch for flash. If flash is seen on test, indicating that cable is bare or terminals grounded, inspect cable and connections. Service if practical, or replace cable. If no flash is seen during these tests, close the master switch, and repeat flash tests. If a flash is seen, test the faulty circuit for dead shorts. If no flash is seen on these tests, make ammeter test (step (*c*) below).

(c) Test With Ammeter. Connect one lead of test ammeter to positive post of battery, and the other lead to 24-volt cable and observe meter. (A reading will be seen as some of the sending units on the engines are connected directly to the main circuit.) If a reading of more than 1 ampere is obtained, indicating a shorted or grounded circuit, disconnect leads from negative (right) end of shunt, one at a time, starting with largest cable (regulator lead), until the faulty circuit is located. If a heavy current draw is indicated on ammeter before disconnecting lead, and is corrected when cable is removed from terminal, test regulator for faulty circuit breaker. Disconnect battery cable marked "B" in regulator terminal box, and repeat ammeter test. If no reading is obtained, replace the regulator (par. 89). If no change is indicated in ammeter reading, continue to disconnect circuits from shunt and bus bar until the faulty circuit is located; then test faulty circuit for shorts or grounds.

(6) CIRCUIT BREAKER FAULTY. If ammeter on instrument panel shows a heavy discharge when generator is not running, and all

switches are off except the master switch, disconnect battery lead marked "B" in regulator terminal box. If condition is corrected, the regulator circuit breaker contact points are stuck. If ammeter on instrument panel does not show charge until generator is running at high speed, the regulator circuit breaker is adjusted to operate at too high a voltage. In either of these cases, replace regulator (par. 89).

(7) REGULATOR INOPERATIVE. Start engine and observe ammeter on instrument panel. If no charging rate is indicated, connect battery and armature terminals marked "A" and "B" together in the regulator terminal box, using a short piece of insulated wire. Hold jumper wire across the two terminals, and watch ammeter. If reading is obtained, regulator is not connecting generator to battery. If this test does not reveal the trouble, connect battery and field terminals together with jumper wire. If a reading is obtained, regulator is not allowing current to reach generator field coils, which prevents charge reaching the battery. If excessive charge is experienced and the batteries and circuits test properly, the trouble is caused by improper regulator adjustment. In either case, the regulator is inoperative. Replace inoperative regulator (par. 89 **b** and **c**).

(8) GENERATOR INOPERATIVE. If regulator tests have been made and no charge is obtained, connect a test voltmeter between armature terminal marked "A" in regulator terminal box and ground (hull). This test will show if generator is charging. If no voltage reading is shown, leave the voltmeter connected and connect battery and field terminals marked "B" and "F" together with jumper wire. A flash will be seen and test voltmeter will show a reading when jumper wire is connected, if circuit is complete. Check ammeter on instrument panel. If a charge is shown, the trouble has been corrected by flashing the fields, which has increased the magnetism or properly polarized the field coil shoes. If no reading is obtained on voltmeter, inspect terminals at generator for loose or broken connections. If no trouble is observed in connections or leads, generator is inoperative. Replace inoperative generator (par. 88 **b** and **c**).

b. Ammeter Does Not Show Charge.

(1) GENERATOR CIRCUIT BREAKER OPEN. Reset generator circuit breaker.

(2) AMMETER INOPERATIVE. If ammeter fails to register a charge, turn on all lights and see if a discharge is shown. If no discharge is observed, connect a new ammeter temporarily to leads in instrument panel. If a reading is obtained, ammeter is faulty. If no reading is obtained, test wiring from ammeter to shunt for open circuit. Replace faulty ammeter (par. 98 **c**).

(3) REGULATOR INOPERATIVE. The test and correction for this step is indicated in subparagraph **a** (7) above.

(4) GENERATIVE INOPERATIVE. The test and correction for this step is indicated in subparagraph **a** (8) above.

(5) LOOSE OR CORRODED CONNECTIONS. Clean and tighten connections.

(6) GENERATOR BOND STRAP LOOSE OR BROKEN. Inspect bond strap. Tighten or replace as required.

c. Ammeter Shows Excessive Charge.

(1) CURRENT REGULATOR IMPROPERLY ADJUSTED. The test and correction for this trouble is indicated in subparagraph **a** (7) above.

(2) BATTERIES RUN DOWN. Test batteries as indicated in paragraph 92 **a**; if found with low charge, replace batteries as indicated in paragraph 92 **b** and **c**.

(3) BATTERIES SHORTED INTERNALLY. Test batteries and replace if faulty (par. 92 **a**, **b**, and **c**).

(4) LOOSE CONNECTIONS ON SHUNT. Check shunt visually for loose connections. Tighten as required.

d. Ammeter Shows Discharge With Engine Running.

(1) GENERATOR NOT OPERATING. Test and correction are indicated in subparagraph **a** (8) above.

(2) REGULATOR CIRCUIT BREAKER CUT-IN VOLTAGE TOO HIGH. Check and correct as indicated in subparagraph **a** (6) above.

(3) SHORTED CIRCUITS. Check and correct as indicated in subparagraph **a** (5) above.

(4) GENERATOR DRIVE BELTS LOOSE OR BROKEN. Tighten or replace belts as indicated in paragraph 88 **c** (2).

e. Ammeter Shows Heavy Discharge With Engine Stopped.

(1) SHORTED CIRCUITS. Check and correct as indicated in subparagraph **a** (5) above.

(2) REGULATOR CIRCUIT BREAKER POINTS STUCK. Test and correct as indicated in subparagraph **a** (6) above.

(3) AMMETER HAND STICKING OR AMMETER BURNED OUT. Test as indicated in subparagraph **b** (2) above. Replace ammeter, if defective, as indicated in paragraph 98 **c**.

f. Ammeter Hand Fluctuates Rapidly.

(1) GENERATOR DRIVE BELTS LOOSE. Tighten or replace belts as indicated in paragraph 88 **c** (2).

(2) GENERATOR BOND STRAP LOOSE OR BROKEN. Inspect and tighten or replace bond strap as required.

(3) REGULATOR CIRCUIT BREAKER CUT-IN VOLTAGE TOO LOW OR CONTACTS BURNED. Tests and correction are indicated in step (5) below.

(4) REGULATOR LOOSE, NOT PROPERLY GROUNDED, OR VIBRATING AGAINST OTHER EQUIPMENT. Tighten regulator on mountings, inspect bond straps, and relieve interference.

(5) GENERATOR OR REGULATOR FAULTY. If ammeter needle fluctuates rapidly while generator is running, test all regulator and generator mountings to see if they are tight, and inspect for broken bond straps. If bond straps and mountings are satisfactory, the condition is caused by incorrect setting of regulator circuit breaker, worn generator brushes, faulty generator drive belts, or regulator bumping against other equipment. If inspection reveals that generator drive belts are properly adjusted (par. 88 **b** (2)) and there is no interference with the regulator, connect a jumper wire between battery terminal marked "B" and armature terminal marked "A" in the regulator terminal box. If the fluctuation stops with the jumper wire connected, indicating that the regulator circuit breaker points have been vibrating, replace regulator (par. 89 **b**). If fluctuation continues, indicating that generator is at fault, replace generator (par. 88 **b** and **c**).

36. RADIO INTERFERENCE SUPPRESSION.

a. General. Most types of radio interference have characteristic sounds. Electrical disturbances which cause radio interference are loose bonds, loose lock washers, broken or cracked suppressors, loose connections, or faulty filters. Following are tests which can be made to determine the cause of interference. Utilize a radio-equipped vehicle placed about 10 feet from the vehicle under test as a test instrument to localize troubles and to determine when faulty parts or conditions have been eliminated or corrected. The cooperation of the radio operator is required. Determine the circuits causing noise by checking as follows:

(1) Operate engine while listening to radio. A regular clicking which varies with engine speed and ceases the instant the ignition is shut off is caused by the ignition circuit.

(2) An irregular clicking which continues a few seconds after the ignition is shut off is caused by the regulator.

(3) A whining noise, which varies with engine speed and continues a few seconds after the ignition is shut off, is caused by generator.

b. Noise Caused by Ignition Circuit.

(1) Make certain ignition system is functioning properly (par. 34). (Improper spark plug gaps, late timing, poor adjustment of breaker points, and damaged or worn distributor blocks in the magneto will affect the suppression system.)

(2) Inspect spark plugs and spark plug leads. Replace any that are scorched, cracked, or otherwise faulty. Be sure wires are tightly installed.

(3) Inspect distributor blocks in magnetos. Replace if necessary.

(4) Inspect and tighten all bonds.

(5) Inspect suppression condensers and filters in regulator, condensers in instrument panel, and in windshield wiper, if installed. Make certain mounting bolts are tight.

c. Noise Caused by Regulator.

(1) Check all connections to regulator.

(2) Check regulator mounting bolts for tightness and correct placement of lock washers and bond straps.

(3) Test for noise.

(4) Check regulator condenser connections.

(5) Test for noise.

(6) If noise is still present, replace condenser.

(7) Check all connections to filter.

(8) Test for noise.

(9) If noise is still present, replace filter.

(10) Test for noise.

d. Noise Caused by Generator.

(1) Check to make certain there is no excessive sparking at brushes. Correct if necessary.

(2) Inspect lead wire and ground wire mounting, and check placement of lock washers.

(3) Check generator mounting bracket, and make sure generator is securely mounted.

e. Noise Observed While Vehicle is in Motion, But Not When Stopped.

(1) Inspect and tighten all bonds and clips.

(2) Check to make certain that all panels and electrical boxes are securely mounted.

(3) Check all electrical connections for security of mounting.

37. FUEL SYSTEM.

a. Fuel Does Not Reach Carburetor.

(1) LACK OF FUEL. Check gage on instrument panel and replenish fuel.

(2) FUEL VALVES NOT TURNED ON. Turn on fuel valves.

(3) CLOGGED GAS TANK VENTS. Open gas tank vents.

(4) INOPERATIVE FUEL PUMP: CLOGGED FUEL FILTER OR LINES. Check fuel flow from the tanks. If fuel does not flow freely at filter, service fuel filter (par. 63 g). If fuel flows freely through filter but does not reach carburetor, the fuel pump is inoperative.

b. Fuel Does Not Reach Cylinders.

(1) INOPERATIVE PRIMER PUMP. Remove one of the primer lines from one of the cylinders, and operate the primer pump to see if fuel enters the cylinder.

(2) PRIMER PUMP STRAINER CLOGGED. Clean or replace as indicated in paragraph 66 b.

(3) CARBURETOR STRAINER CLOGGED. Clean or replace as indicated in paragraph 61 d.

(4) THROTTLE NOT OPENING. Adjust throttle as indicated in paragraph 67 e.

(5) CARBURETOR JETS CLOGGED. Replace carburetor as indicated in paragraph 61 e and f.

(6) LOW FUEL PUMP PRESSURE. Install a fuel pump pressure gage (41-G-500) in the outlet side of the fuel pump and test pressure. Pressure should read 3½ pounds. Replace fuel pump if pressure is low (par. 62).

38. ENGINE OILING SYSTEM.

a. Low or No Oil Pressure.

(1) LACK OF OIL. Replenish oil supply as indicated in paragraph 70 d.

(2) CLOGGED OIL LINES OR INOPERATIVE OIL PUMP. Loosen inlet connection at oil pump, and apply compressed air to open end of hose. When free passage to oil supply tank is established, fill line with oil and connect inlet hose to oil pump. Remove oil pressure relief valve, crank engine with cranking motor, and observe if oil is discharged from relief valve opening. If no oil is discharged, replace the oil pump (par. 72 b and c).

(3) LEAKING OIL LINES OR FITTINGS. Tighten or replace as required.

(4) PRESSURE GAGE INOPERATIVE. If low pressure warning light goes out after engine starts, there is oil pressure. If gage registers no pressure or insufficient pressure, ground lead wire at sending unit; if gage indicates full pressure, replace sending unit (par. 72 d).

(5) PRESSURE RELIEF VALVE STUCK OR SET TOO LOW. Watch oil pressure gage; turn oil pressure adjusting screw, and check for variation of pressure. If no change is evident, service the relief valve assembly (par. 77).

b. Oil Temperature Too Low.

(1) OIL TEMPERATURE GAGE OR SENDING UNIT INOPERATIVE. Stop engine and allow oil to cool. If gage reading is not reduced as oil cools off, disconnect wire from sending unit; if reading then drops, replace the sending unit (par. 72 **d**). If the gage indicates high oil temperature with wire disconnected from sending unit, replace the gage (par. 98).

(2) BY-PASS VALVE INOPERATIVE. Remove cap on top of by-pass valve, take out the valve, and check it for freedom of operation. Replace if inoperative (par. 75 **e** and **f**).

c. Oil Temperature Too High.

(1) LOW OIL SUPPLY. Fill with oil as indicated in paragraph 70 **d**.

(2) AIR INTAKE GRILLE OR SCREEN CLOGGED WITH FOREIGN MATTER. Remove all obstructions.

(3) ACCUMULATION OF OIL OR DIRT ON EXTERIOR OF ENGINE. Clean engine.

(4) ENGINE OIL COOLER OBSTRUCTED OR COVERED. Loosen the coupling at outlet from engine oil cooler to oil supply tank. If normal flow of oil is not evident, loosen inlet line at bottom of cooler, and check for flow of oil to cooler. If normal flow of oil is found at this point, oil cooler is clogged. Remove and clean (par. 75 **b**).

(5) LATE IGNITION TIMING. Reset timing as indicated in paragraphs 54 **c**, 55 **c**, and 56.

(6) INOPERATIVE BY-PASS VALVE. Refer to subparagraph **b** (2) above.

39. LIGHTING SYSTEM.

a. All Lights Will Not Burn.

(1) MASTER SWITCH TURNED OFF. Turn switch on.

(2) FAULTY OR DISCHARGED BATTERIES. The battery tests are indicated in paragraph 92 **a**. If battery tests indicate low charge, replace with a fully charged battery as indicated in paragraph 92 **b** and **c**.

(3) LOOSE OR CORRODED TERMINALS. Clean and tighten connections as required.

(4) MASTER SWITCH INOPERATIVE. Test master switch with low voltage electrical testing equipment and replace if switch is defective (par. 93 **d** (3) and **e** (8)).

b. All External Lights Will Not Burn.

(1) MASTER SWITCH TURNED OFF. Turn switch on.

(2) FAULTY OR DISCHARGED BATTERIES. The battery tests are

indicated in paragraph 92 a. If battery tests indicate low charge, replace with a fully charged battery as indicated in paragraph 92 b and c.

(3) LOOSE OR CORRODED TERMINALS. Clean and tighten connections as required.

(4) FAULTY LIGHTING SWITCH OR SHORT CIRCUITS. Turn on battery switch and instrument panel light switch. If batteries, connections, and wiring are satisfactory, the panel lights will burn, indicating that current is reaching the instrument panel. If all external lights fail to operate, turn off main lighting switch and push light circuit breaker reset button to make sure that it is not kicked out. CAUTION: *Do not hold circuit breaker reset button in, as a short circuit would damage the circuit breaker or set fire in the wiring.* Slowly turn light switch from one contact to another. If the switch and wiring connections inside panel, and the conduit connections on back of panel, are satisfactory, some of the lights will burn. When the faulty circuit is contacted with the switch, the circuit breaker will kick out, indicating a short. Test that circuit for trouble and correct (subpar. f (4) below). If no short exists and all external lights do not function, loose wiring connections or a faulty main lighting switch are indicated. Inspect for loose connections and/or replace switch if defective (par. 98 c).

(5) OPEN CIRCUIT. Check for broken or disconnected wire.

(6) MASTER SWITCH INOPERATIVE. Test master switch with low voltage electrical testing equipment, and replace if switch is defective (par. 93 d (3) and e (8)).

c. All Internal Lights Will Not Burn.

(1) MASTER SWITCH TURNED OFF. Turn switch on.

(2) BATTERIES DISCHARGED. The battery tests are indicated in paragraph 92 a. If battery tests indicate low charge, replace with a fully charged battery as indicated in paragraph 92 b and c.

(3) LOOSE OR CORRODED TERMINALS. Clean and tighten connections.

(4) SHORT CIRCUITS (ACCESSORIES CIRCUIT BREAKER KICKED OUT). The instrument panel lights and outlet receptacle on the instrument panel, are all fed through the accessories circuit breaker. If a short exists causing the circuit breaker to kick out with the instrument panel light switch turned off, the trouble would be in the outlet receptacle on instrument panel or connected accessory. If the short circuit or faulty operation exists only when the panel light switch is turned on, the wiring in the panel or the panel light switch is faulty. Inspect wiring in the panel and test for complete circuit through the

panel light switch with a voltmeter. If panel light switch is at fault, replace the switch (par. 98 c).

(5) OPEN CIRCUIT. Check for broken or disconnected wire.

(6) MASTER SWITCH INOPERATIVE. The battery tests are indicated in paragraph 92 a. If battery tests indicate low charge, replace with a fully charged battery as indicated in paragraph 92 b and c.

d. All Lights Burn Dim.

(1) BATTERIES DISCHARGED OR LOOSE OR CORRODED TERMINALS. Clean and tighten terminals. The battery tests are indicated in paragraph 92 a. If battery tests indicate low charge, replace with a fully charged battery as indicated in paragraph 92 b and c.

(2) MASTER SWITCH CONTACTS BURNED. Replace switch.

(3) LOOSE CONNECTIONS IN INSTRUMENT PANEL FEED WIRES CAUSING HIGH RESISTANCE. Tighten connections.

e. One or More Lamp-units Burn Out Continually.

(1) BOND STRAPS OR CONNECTIONS LOOSE OR BROKEN. Clean and tighten all connections; replace broken bond straps.

(2) BATTERY GROUND CABLE LOOSE OR BROKEN. Tighten or replace cable.

(3) GENERATOR REGULATOR IMPROPERLY ADJUSTED. This is indicated by ammeter reading being too high and a hot generator. Strike the regulator case several light blows with a light hammer, and if the charging rate still remains too high, replace the regulator (par. 89).

f. Individual Lights or Circuits Inoperative.

(1) LAMP BURNED OUT. Replace lamp as shown in paragraph 100 c.

(2) LOOSE CONNECTIONS AT LIGHT. Tighten connections as required.

(3) BROKEN WIRING OR DAMAGED CONDUIT TO UNIT. Replace conduit and wiring, or report to higher authority.

(4) SHORT CIRCUITS OR GROUNDS (CIRCUIT BREAKERS KICK OUT). If short circuits are encountered, disconnect the conduit connectors or wires from the inoperative unit. If the trouble is eliminated and the circuit breaker remains in contact when reset, the trouble is in the unit. Inspect, make corrections if practical, or replace faulty units. If the condition prevails after disconnecting the conduit connector or wire at unit, disconnect the conduit containing the inoperative circuit from back of instrument panel. If condition is relieved, trouble is in conduit. Replace faulty conduit, or notify higher authority. If the trouble still exists after disconnecting con-

duit from instrument panel, the trouble is in panel wiring, light switches, or circuit breaker. Disconnect the faulty circuit from switch to determine if wiring is at fault. If the trouble still exists, replace faulty switch.

40. CLUTCH.

a. Clutch Drag. Idle engine at 800 revolutions per minute. Push clutch pedal to fully released position, and allow time for clutch to stop. Shift transmission into first or reverse gear. If shift cannot be made without a severe clash of gears; or if, after engagement of gears, there is a jumping or creeping movement of the vehicle with the clutch still fully released, the clutch is at fault. If linkage is properly adjusted and not binding, and clutch is faulty, it must be removed from vehicle, disassembled, cleaned and inspected, and defective parts must be replaced (par. 109).

(1) EXCESSIVE PEDAL CLEARANCE. Adjust clutch linkage as indicated in paragraph 112.

(2) WARPED OR CRACKED DRIVING OR DRIVEN PLATES. Remove and disassemble clutch. Inspect parts, and replace any parts that are defective (par. 109).

(3) EXCESSIVE DIRT IN CLUTCH ASSEMBLY. Disassemble clutch and clean out (par. 109).

(4) METAL TRANSFER OR BONDING OF CLUTCH FACINGS. Replace damaged plates (par. 109).

b. Clutch Slips.

(1) LOSS OF SPRING LOAD CAUSED BY EXCESSIVE HEAT OR BROKEN SPRINGS. Notify higher authority.

(2) DIRT IN CLUTCH CAUSING BINDING OF DRIVEN PLATES. Disassemble and clean out (par. 109).

(3) CLUTCH DRIVEN PLATE FACINGS WORN. Replace driven plates (par. 109).

c. Complete Failure of Clutch to Engage or Release.

(1) DISCONNECTED CLUTCH LINKAGE OR BINDING OF CLUTCH LINKAGE. Inspect linkage. Replace or connect parts (par. 112).

(2) BROKEN OR DAMAGED CLUTCH PLATES. Replace damaged plates (par. 109).

(3) DAMAGED CLUTCH SPINDLE OR BEARING. Replace damaged parts (par. 111).

(4) EXCESSIVE PEDAL FREE PLAY. Adjust pedal free play (par. 112).

TROUBLE SHOOTING

41. PROPELLER SHAFT.

a. Backlash.

(1) WORN OR DAMAGED UNIVERSAL JOINT CROSS BEARING. Inspect and replace as required (par. 116).

(2) LOOSE BOLTS AT UNIVERSAL JOINT COMPANION FLANGES. Tighten bolts as required.

(3) UNIVERSAL JOINT COMPANION FLANGES LOOSE ON TRANSMISSION INPUT SHAFT OR ON CLUTCH FLANGE. Tighten flange bolts.

b. Vibration in Propeller Shaft.

(1) WORN OR DAMAGED UNIVERSAL JOINTS. Inspect and replace if found defective (par. 116).

(2) LOOSE BOLTS AT UNIVERSAL JOINT COMPANION FLANGES. Tighten flange bolts as required.

42. TRANSMISSION AND FINAL DRIVE ASSEMBLY.

a. Lubricant Leakage.

(1) DAMAGED GASKET AT FILLER PLUG. Replace gasket.

(2) LOOSE DRAIN PLUGS. Tighten.

(3) DAMAGED FLEXIBLE HOSE OR COOLER TUBES. Replace hose or tubes.

(4) DAMAGED FINAL DRIVE HOUSING COVER GASKET OR LOOSE CAP SCREWS. Tighten cap screws or replace gaskets (par. 129).

(5) DAMAGED BRAKE INSPECTION COVER GASKET. Inspect and replace gasket if defective (par. 129).

(6) DAMAGED GASKET BETWEEN TRANSMISSION AND FINAL DRIVE HOUSING. Notify higher authority.

(7) WORN OR DAMAGED INPUT OR OUTPUT SHAFT OIL SEALS OR GASKET. Notify higher authority.

(8) DAMAGED GASKET AT TRANSMISSION INSPECTION PLATE. Replace gasket.

b. Track Will Not Move on One Side (Engine Running and Transmission in Gear).

(1) BROKEN FINAL DRIVE SHAFT OR COMPENSATING SHAFT. Replace final drive unit (pars. 125 and 129).

(2) TOOTH STRIPPED ON FINAL DRIVE SHAFT GEAR OR COMPENSATING GEAR. Replace final drive unit (pars. 125 and 129).

(3) BROKEN FINAL DRIVE ASSEMBLY PARTS. Notify higher authority.

c. Hard Shifting (Severe Gear Clash).

(1) INCORRECT CLUTCH LINKAGE ADJUSTMENT. Adjust as indicated in paragraph 112.

(2) CLUTCH DRAGGING. Refer to paragraph 40 a for correction.

(3) BINDING OF TRANSMISSION GEARSHIFT LEVER. Notify higher authority.

(4) DAMAGED TRANSMISSION PARTS. Notify higher authority.

d. Backlash.

(1) WORN OR DAMAGED FINAL DRIVE ASSEMBLY. Notify higher authority.

(2) WORN OR DAMAGED TRANSMISSION PARTS. Notify higher authority.

e. Poor Steering.

(1) STEERING BRAKES NOT PROPERLY ADJUSTED. Adjust as indicated in paragraph 122.

(2) STEERING BRAKE SHOE LINING WORN OR DAMAGED. Notify higher authority.

43. TRACKS AND SUSPENSION.

a. Bogie Wheel Tire Wear.

(1) TRACK CONNECTOR BENT, BROKEN, OR MISSING. Replace connector as indicated in paragraph 134.

(2) DEAD TRACK SHOE. Replace track shoe as indicated in paragraph 134 **c**.

(3) DAMAGED TRACK. Replace track as indicated in paragraph 134 **a** and **b**.

(4) MUD COLLECTING IN TRACK BETWEEN END CONNECTORS. Remove mud from connectors.

(5) WORN GUDGEON BUSHINGS IN BOGIE WHEEL ARMS. Replace arms as indicated in paragraph 137 **c** (2).

b. Volute Spring Breakage.

(1) WORN GUDGEONS. Replace gudgeons as indicated in paragraph 137.

(2) WEAK SPRINGS. Replace both springs as indicated in paragraph 138.

(3) BROKEN OR CRACKED SPRING SEATS. Replace spring seats as indicated in paragraph 138.

(4) SEIZED LEVER BUSHINGS. Replace bushings as shown in paragraph 138.

c. Thrown Tracks.

(1) IMPROPER TRACK TENSION. Adjust track tension as indicated in paragraph 134 **d**.

(2) ROCK BETWEEN TRACK AND IDLER. Clean out.

(3) MISALINEMENT OF IDLER WHEEL. Tighten bracket bolts.

(4) IDLER SHAFT LOOSE IN BRACKET. Lock idler adjustment as indicated in paragraph 135.

d. Inoperative Track Supporting Rollers.

(1) MUD BETWEEN ROLLERS AND TRACK. Remove mud.

(2) BEARINGS SEIZED. Replace roller assembly as shown in paragraph 136.

(3) INSUFFICIENT LUBRICATION. Lubricate roller periodically as indicated in paragraph 21.

e. Inoperative Idler Wheel.

(1) BEARINGS SEIZED. Replace bearings as shown in paragraph 135.

(2) INSUFFICIENT LUBRICATION. Lubricate bearings periodically as shown in paragraph 21.

Section XIII

ENGINE DESCRIPTION AND MAINTENANCE IN VEHICLE

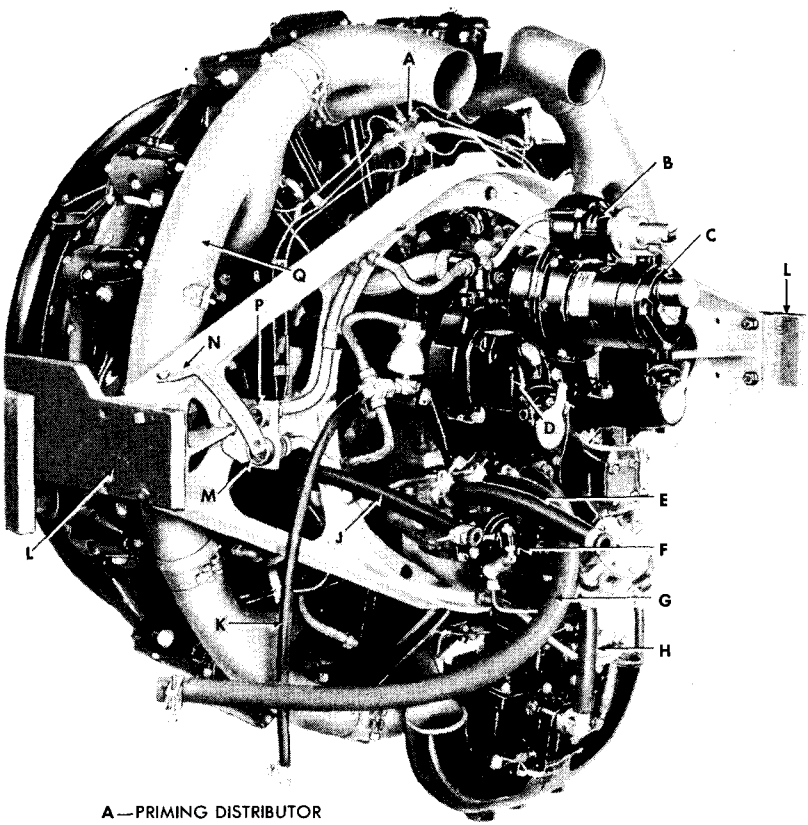
44. DESCRIPTION (figs. 17, 18, and 19).

a. The engine used in the vehicle is a 9-cylinder, air-cooled, radial engine, model R-975-C1. The engine is mounted in the rear of the hull and cooled by air drawn through an air inlet shutter in the engine compartment top plate by means of the engine fan. The engine accessories are mounted on the rear of the engine, and are accessible through the engine compartment rear doors. The terms "RIGHT," "LEFT," "FRONT," and "REAR" are used in relation to the driver's position as he sits in the vehicle. The direction of rotation is determined by viewing the engine from the rear of the vehicle. A plate which bears the engine serial number is attached to the front section of the crankcase. The number is also stamped on the cranking motor housing of the crankcase and on each rocker arm box.

45. DATA.

Compression ratio	5.7 to 1
Bore	5.00 in.
Stroke	5.50 in.
Displacement	973 cu in.
Rated horsepower	400 at 2,400 rpm
Firing order (No. 1 cylinder at top: cylinders numbered clockwise, from rear)	1-3-5-7-9-2-4-6-8

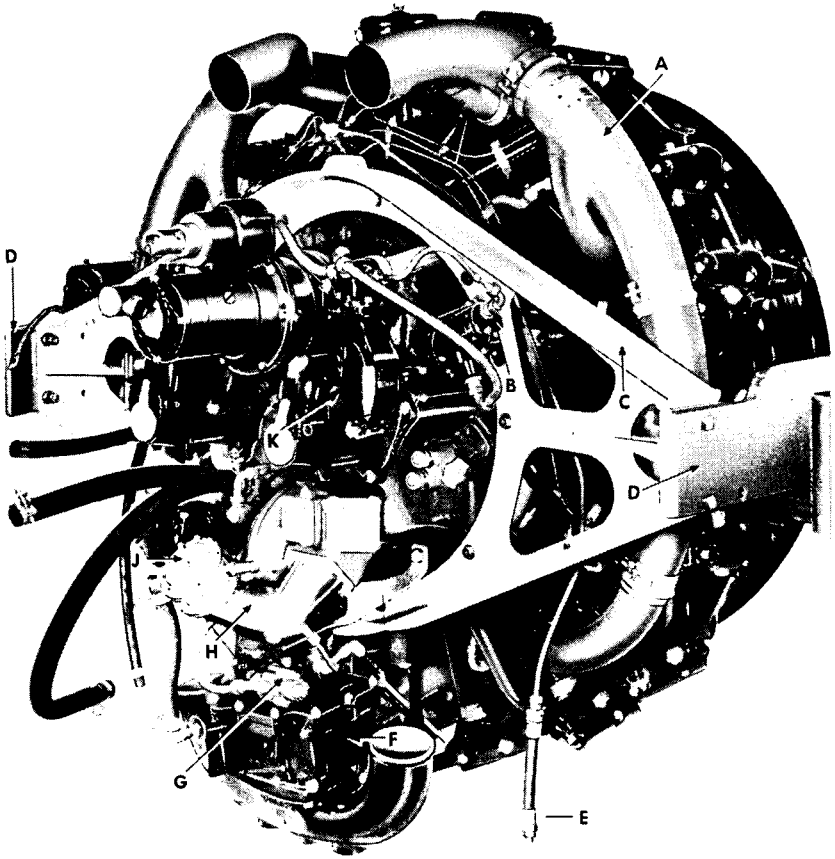
CARRIAGE, MOTOR, 105-MM HOWITZER, M7



A—PRIMING DISTRIBUTOR
B—HAND CRANKING ATTACHMENT
C—CRANKING MOTOR
D—LEFT MAGNETO
E—MAIN SCAVENGER OUTLET TUBE
F—GOVERNOR
G—OIL PUMP INLET TUBE
H—CARBURETOR FUEL INTAKE TUBE
J—FRONT SCAVENGER OUTLET TUBE
K—OIL PRESSURE TUBE
L—ENGINE STAND
M—CONNECTOR (ENGINE INSTRUMENTS WIRING HARNESS)
N—BOND STRAP
P—CONNECTOR (ENGINE MAGNETO WIRING HARNESS)
Q—EXHAUST MANIFOLD CYLINDERS, NOS. 5, 6, 7, 8, AND 9 RA PD 322862

Figure 17 — Left Rear View of Engine

ENGINE DESCRIPTION AND MAINTENANCE IN VEHICLE



A—EXHAUST MANIFOLD FOR CYLINDERS NOS. 1, 2, 3, AND 4

B—BOOSTER COIL

C—ENGINE SUPPORT BEAM

D—ENGINE STAND

E—PRIMING LINE CONNECTOR

F—CARBURETOR

G—IDLE CUT-OFF AND DEGASSER

H—FUEL PUMP ADAPTER ELBOW

J—FUEL PUMP

K—RIGHT MAGNETO

RA PD 322863

Figure 18 — Right Rear View of Engine

Minimum oil pressure	40 lb
Engine oil pressure at operation speed	50 to 90 lb
Engine oil temperature at operating speed	120° F to 190° F
Maximum oil temperature	190° F
Oil capacity (early vehicles)	36 qt
Oil capacity (later vehicles)	52 qt
Spark plug gap	0.017 to 0.019 in.
Valve clearance (cold engine)	0.006 in.
Crankshaft rotation	Clockwise
Fuel pump rotation	Counterclockwise
Cranking motor rotation	Counterclockwise
Magneto rotation	Counterclockwise

46. INTAKE TUBES.

a. Removal. Loosen the clamps and remove the large tubes between carburetor and air cleaners.

b. Installation (fig. 20). Install the air tubes between the air cleaners and the carburetor with hose (G-104-01-00904) and clamp (G-104-15-87891) at the top, and hose (G-104-16-17671) with clamp (G-104-15-37883), at the bottom.

47. EXHAUST MANIFOLDS.

a. General. The exhaust manifolds can be removed in sections or as assemblies. The four upper sections and the three lower sections can be replaced with the engine in the vehicle. To replace the lower sections of the left manifold, it is necessary to remove the inspection plate from the engine compartment floor. If the center sections or the assemblies are to be removed, it is necessary to remove the engine.

b. Removal.

(1) REMOVE UPPER OR LOWER SECTIONS. If the lower section of the left manifold is to be removed, remove plate from engine compartment floor. Loosen the manifold clamps, and slide the clamps away from the junction of the manifold sections. Remove the lock wire and nuts from the flange studs at the cylinder, and remove the section of the manifold.

(2) REMOVE CENTER SECTIONS OR ASSEMBLIES.

(a) Remove Engine (par. 51).

(b) Remove Manifold from Engine. Loosen and move the engine mounting beam away from the manifold far enough to allow the manifold to clear the flange studs. Remove the flange stud nuts. If center section only is to be removed, loosen the clamps and move them away from the junction of the manfold sections.

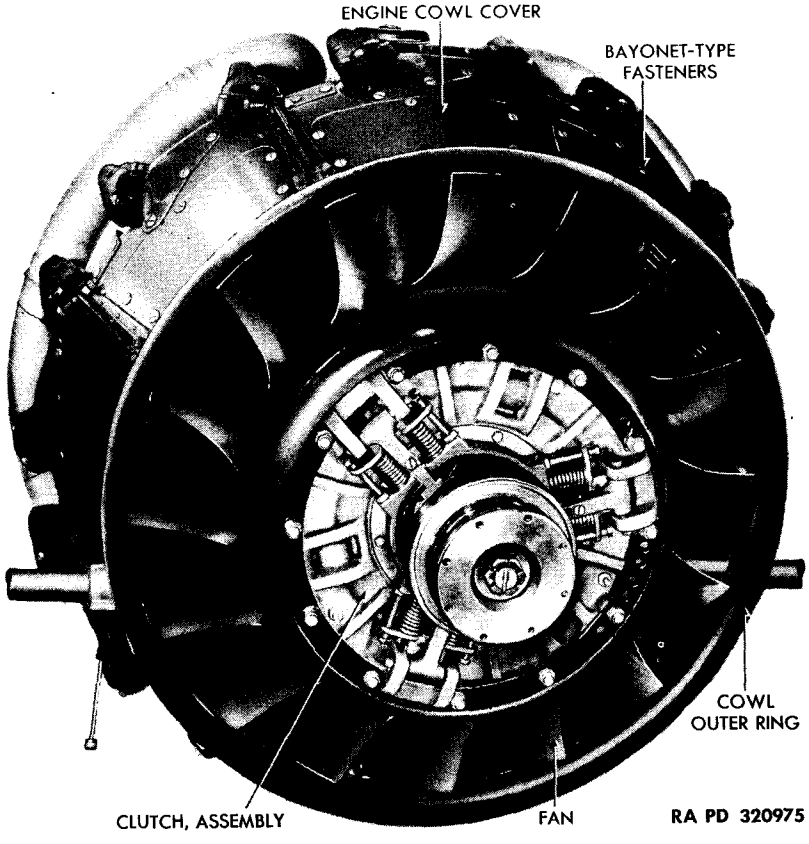


Figure 19 — Front View of Engine

c. **Installation.** Remove all traces of gasket from the flanges, and place new gasket (G-104-01-00680) over the flange studs. Place the manifold clamps over the manifold if they were removed. Position the manifold section or assemblies, and install the flange stud nuts and lock wire. Slide the manifold clamps into position, and tighten if only sections of the manifold were removed. If center section or assembly was removed, install the engine mounting beam, and install the engine (par. 52).

48. VALVE ROCKER ARMS.

a. **Description.** The valve rocker arms are operated by the cam and push rod mechanism. A roller at the valve end of the rocker arm contacts the end of the valve stem. A roller bearing is used

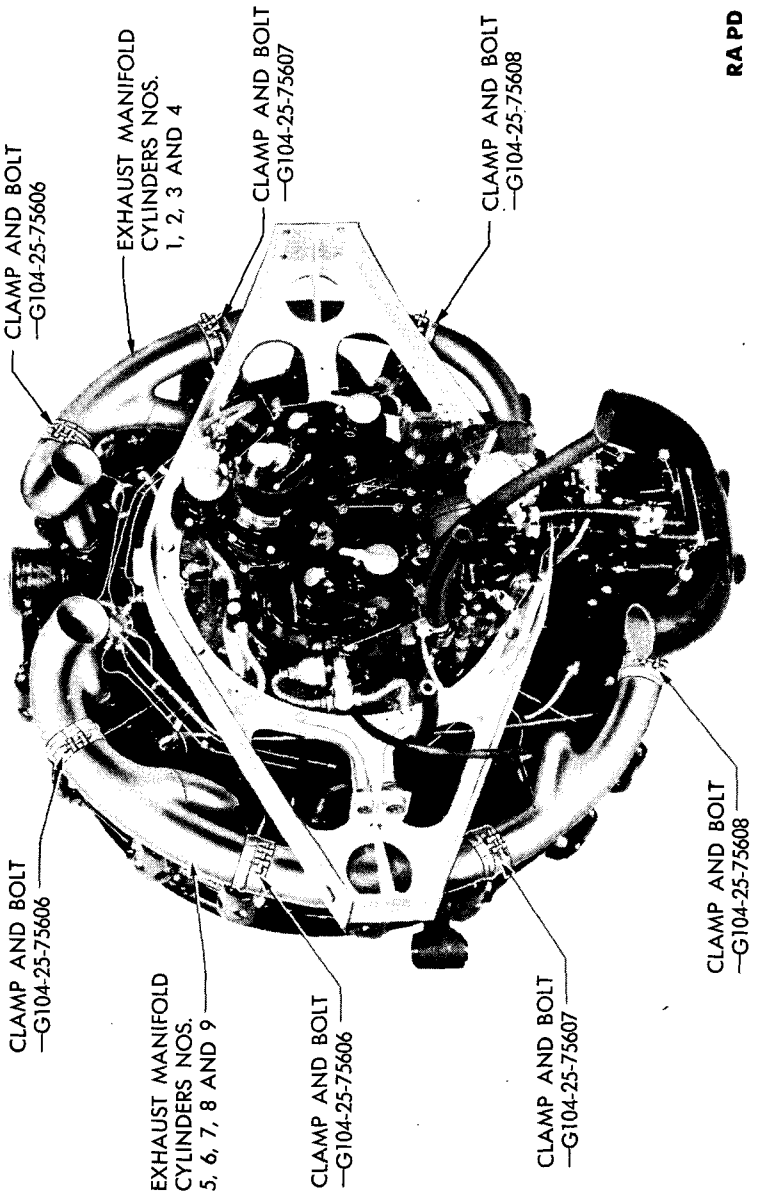


Figure 20 — Exhaust Manifold and Connections

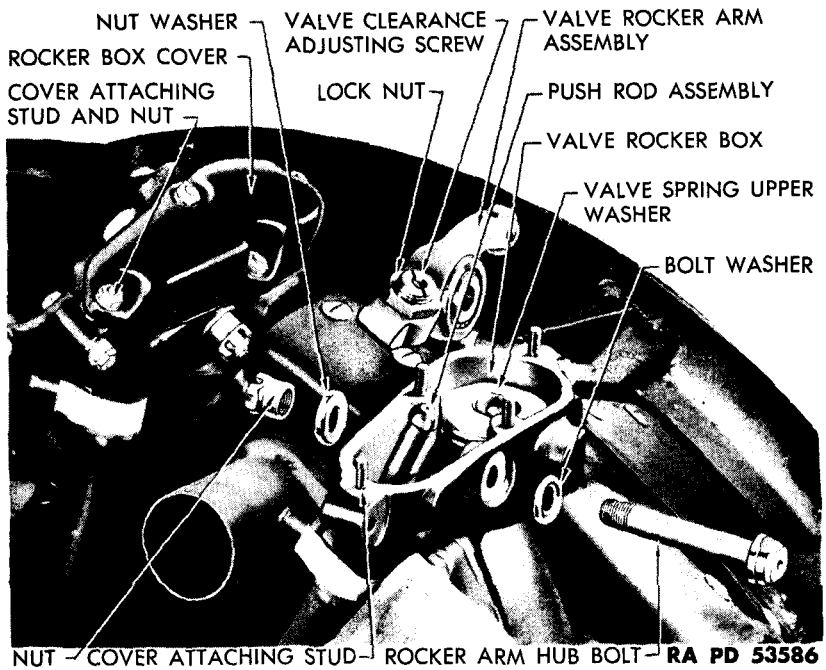


Figure 21 — Rocker Arm Removed

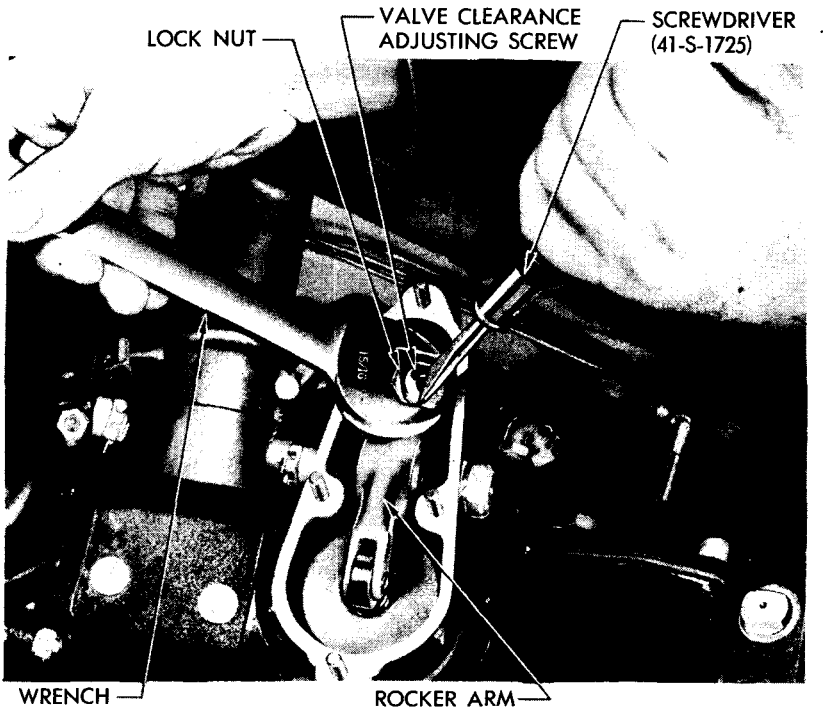
where the rocker arm is supported on the rocker hub bolt. The rocker arms and valve stems are lubricated through oil passages in the push rods.

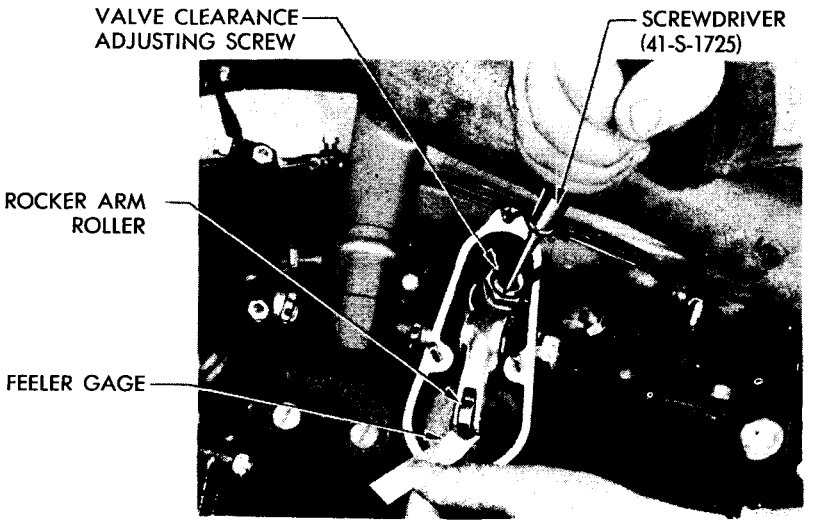
b. Removal (fig. 21). Remove the rocker box cover and gasket. Remove the front or rear spark plugs, and turn the crankshaft until there is clearance between the rocker arm and the valve stem. Remove the nut and washer from the rocker arm hub bolt, and remove the bolt and rocker arm.

c. Installation. Place the rocker arm in position in the rocker arm box. Install the rocker arm hub bolt with a washer under the head and another under the nut. Secure the nut with a cotter pin. Adjust tappet (fig. 22). Place a new gasket over the studs and install the cover (G-104-01-27700), washers, and nuts. Install the spark plugs. Install engine (par. 52).

49. PUSH RODS AND SPRINGS.

a. Removal. Remove the valve rocker arms (par. 48). Loosen push rod housing clamps and remove push rod housings. Fish out the valve tappet ball sockets and spring with a piece of wire, turning the crankshaft, if necessary, to put the socket within reach.





RA PD 53598

Figure 22 — Adjusting Valve Clearance

b. Installation. Place the tappet spring and valve tappet ball socket in position. Install the push rod housings. Hold the housing against the connection at the rocker box end, and tighten the clamps. Blow out the oil passage in the push rod with compressed air to make certain it is clear. Insert the push rod in the housing.

50. VALVE CLEARANCE ADJUSTMENT.

a. Remove Engine (par. 51).

b. Remove Rocker Box Cover (par. 48 b).

c. Inspect Rocker Arms. Before attempting to adjust valve clearance, inspect the rocker arm roller and bearing; if either is damaged, replace the rocker arm.

d. Set Piston at Top of Firing Stroke. Remove the front or rear spark plugs, and turn the crankshaft until the piston is at the top of its stroke with the intake and exhaust rocker arms free.

e. Adjust Clearance (fig. 22). Loosen the adjusting screw lock nut, and turn the adjusting screw until a 0.006-inch feeler gage will just slide between the rocker arm roller and the end of the valve stem, causing the roller to turn.

Section XIV

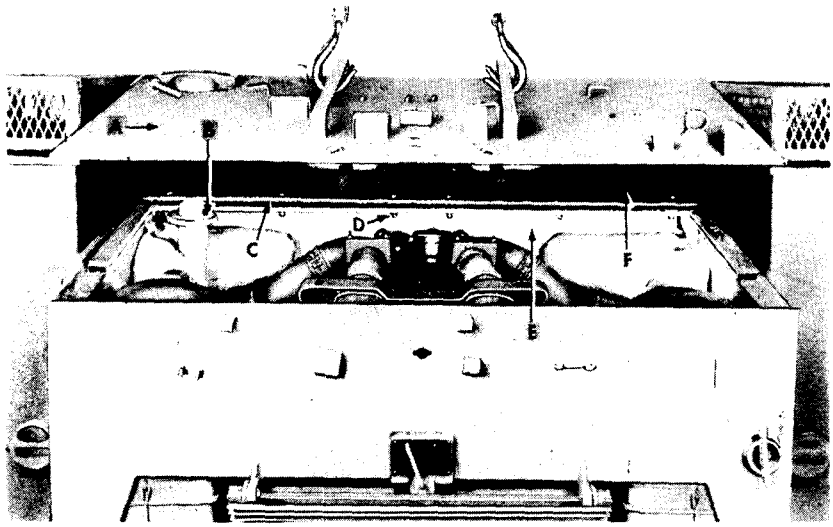
ENGINE REMOVAL AND INSTALLATION

51. REMOVAL.

a. Preliminary Steps. Open battery master switch. Close the two fuel shut-off valves (fig. 6). NOTE: *Early production vehicles have two fuel shut-off valves under the rear section of the crew compartment floor and four at the front top plate of the engine compartment, all of which must be closed. Remove the handles of the two which project through the guard on the engine compartment.*

b. Remove Engine Compartment Rear Top Plate (fig. 23). Remove rear exhaust deflector from its brackets. Remove cap screws which secure rear top plate. Attach a sling and lift off rear top plate.

c. Remove Engine Compartment Front Top Plate (fig. 23). Remove engine compartment rear top plate (subpar. b above). Pull out fuel cap cover pin. Remove wing screws, clamps, and air inlet shutter. Remove rear folding armor plates (par. 160 b). Remove cap screws and bolts which secure front top plate. Attach a sling, and lift off front top plate. Lift off joining plate.



A—ENGINE COMPARTMENT REAR TOP PLATE
B—OIL TANK FILLER PIPE SEAL
C—JOINING PLATE
D—ATTACHING BOLTS
E—ENGINE COMPARTMENT UPPER SHROUD
F—ENGINE COMPARTMENT FRONT TOP PLATE
RA PD 320946

Figure 23 — Removing Engine Compartment Rear Top Plate

d. Remove Engine Compartment Upper Shroud (fig. 23). Remove bolts, washers, and nuts which secure each side of upper shroud to fuel tank shield. Loosen tube clamps at rear end of each upper air intake tube. Disconnect bracket securing each upper air intake tube to fuel tank shields. Work shroud loose and raise it up, pulling shroud free of air intake tubes. Lift out upper air intake tubes.

e. Disconnect Propeller Shaft From Engine. Remove bolts which attach rear universal joint flange and companion clutch flange. Punch-mark the two flanges so they can be assembled in same position.

f. Remove Engine Compartment Floor Inspection Plate (fig. 161). Remove locking wire from cap screws securing inspection plate to floor of engine compartment. Place jack under plate and remove cap screws. Lower the plate and remove from under vehicle.

g. Disconnect Clutch Release Rod From Clutch Throw-out Bracket Equalizer Yoke (fig. 100). Remove cotter pin and clevis pin. Disconnect rod.

h. Remove Exhaust Pipes (par. 105).

i. Remove Lower Air Intake Tubes (figs. 24 and 25). Loosen

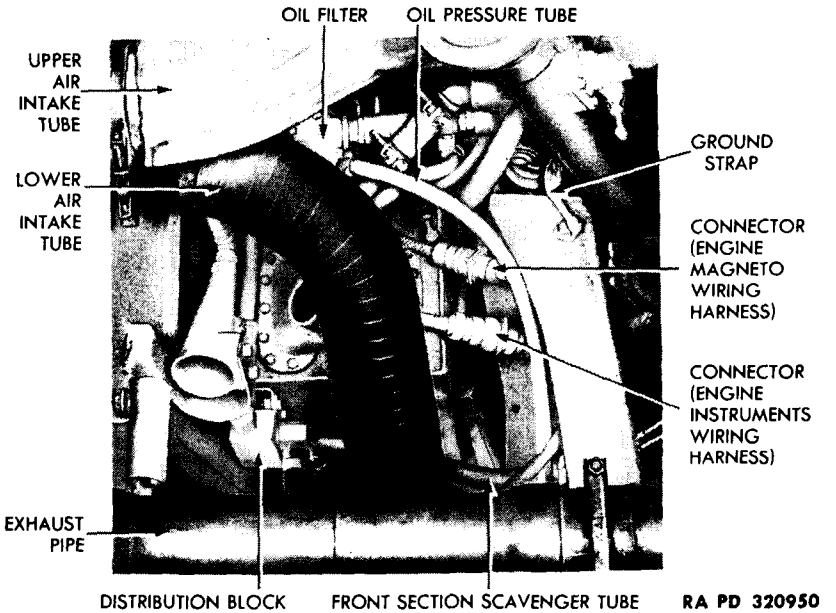
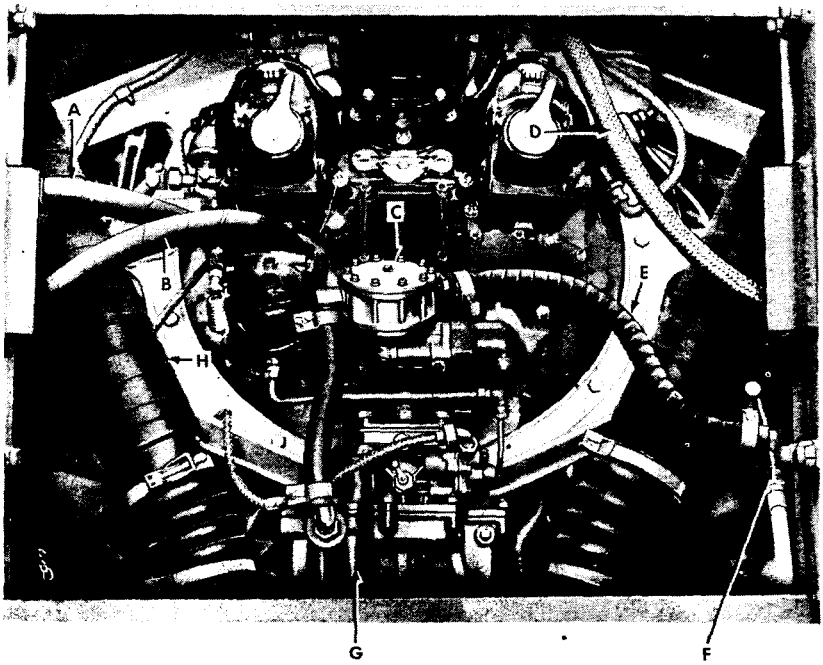


Figure 24 — Disconnections for Removing Engine — Top View (Late Models)

clamps at each end of lower air intake tubes, and pull the tubes away from the air cleaners and carburetor air intake horns. **NOTE:** *Cover the carburetor air intake horns with cloth and secure with wire.*

j. Disconnect Oil and Fuel Lines (figs. 24 and 25). Inspect oil and fuel line connections for evidence of leaks before disconnecting. On late models, disconnect main oil line inlet tube and main scavenger outlet tube from the engine. Disconnect front section scavenger tube at distribution block. On early models, disconnect the inlet and outlet lines at the connections at lower end of each hose. On early models, disconnect front section scavenger line at "Y" connection with oil outlet line. On late models, disconnect the oil pressure tube from the oil filter. On early models, disconnect oil pressure gage line at connection point under left side of engine support beam. Disconnect fuel inlet tube at fuel pump. On early models, disconnect fuel by-pass line at the three-way elbow at carburetor. Disconnect primer distributor line at connection under right side of engine on late models, and under left side of engine support beam on early models. Cover fuel line openings with cloth and secure with wire. On early models, disconnect breather hose connections at top of engine. Pull breather line back through bulkhead into the crew compartment as far as possible to get it out of the way.



RA PD 322859

A—MAIN SCAVENGER OUTLET TUBE
B—OIL LINE INLET TUBE
C—FUEL PUMP
D—CRANKING MOTOR WIRING HARNESS
E—FUEL INLET TUBE
F—PRIMER DISTRIBUTOR LINE
G—CARBURETOR
H—LOWER AIR INTAKE TUBE

Figure 25 — Disconnections for Removing Engine —Rear View (Late Models)

k. Disconnect Electrical Connections — Early Models (fig. 26). Remove generator shield, disconnect wires, and remove conduit from generator. Remove shield, disconnect conduit, and disconnect and remove starter cable at cranking motor. Remove cover from terminal box (fig. 26). Remove both magneto ground wires and the booster primary wire from their posts in the terminal box, tagging each post and wire, as disconnection is made, to assure correct installation. Disconnect magneto grounds and booster primary conduit at terminal box, and pull ground wires and booster wire out of terminal box. Immediately ground magneto ground wires to prevent any possibility of engine starting. Remove cotter pin from clevis pin in fuel cut-off linkage, and remove clevis pin. Remove two bolts that hold fuel cut-off solenoid to bracket on engine support beam and remove solenoid, allowing cable to pass under carburetor. Loosen cable clip on left lower side of engine support beam and release the cable.

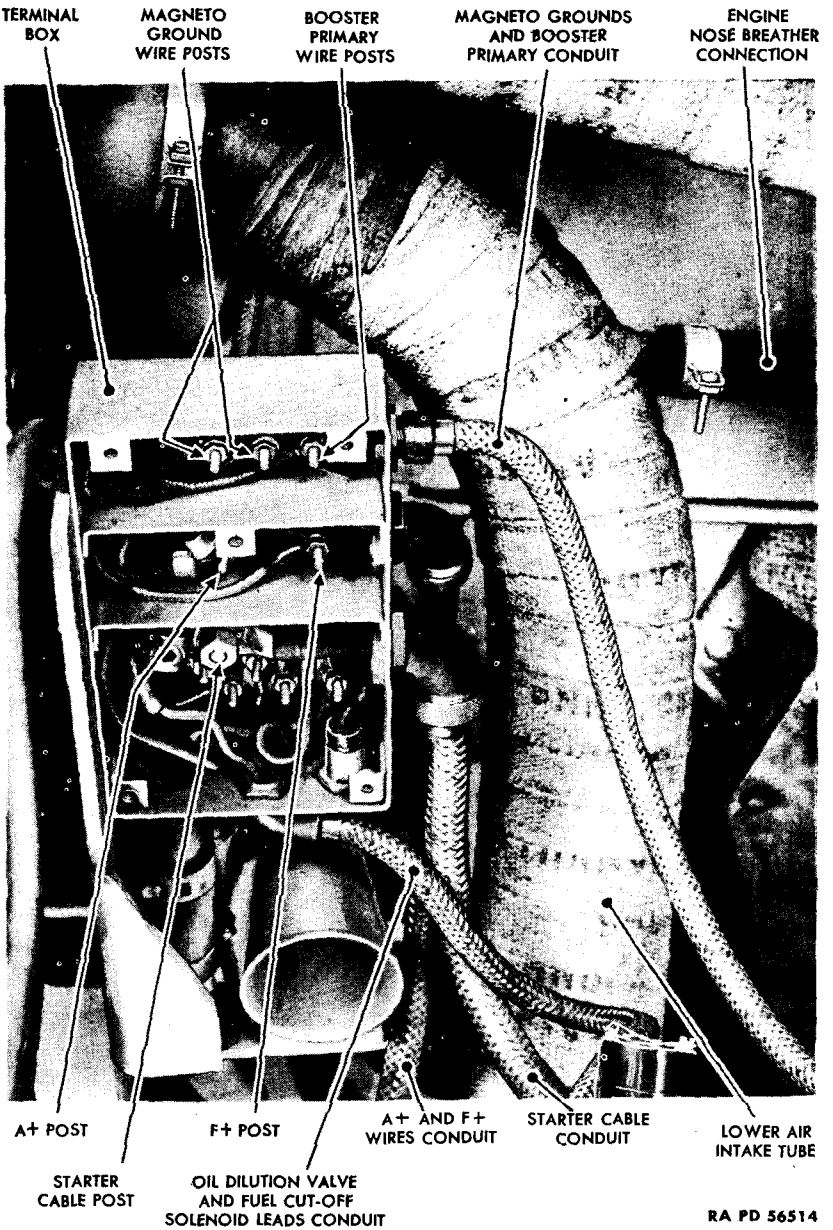


Figure 26 — Engine Compartment Terminal Box With Cover Removed (Early Models)

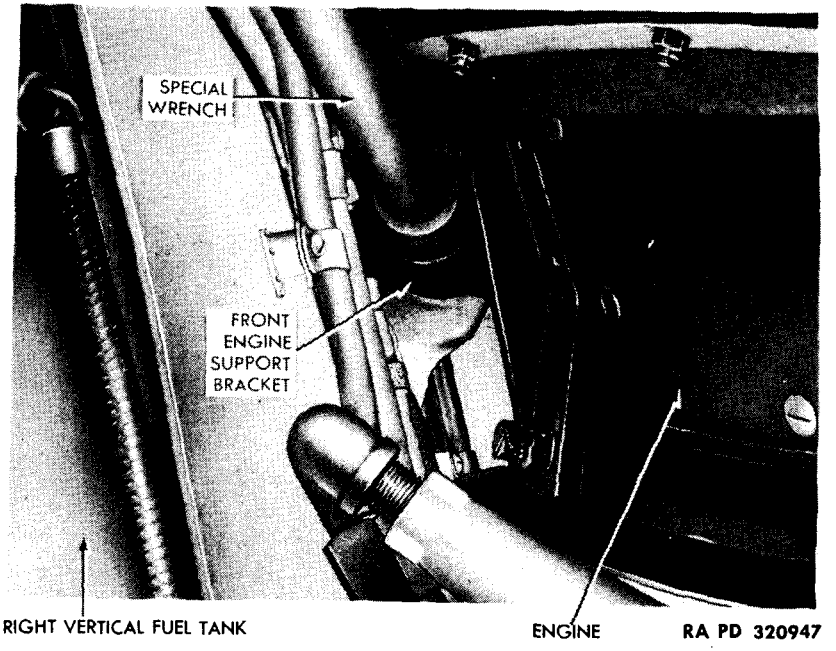


Figure 27 — Using Special Wrench (41-W-906-25) To Remove Engine Support Bolts

l. **Disconnect Electrical Connections — Late Models** (figs. 24 and 25). Remove locking wire from cranking motor terminal housing cover and unscrew the cover. Remove cable terminal nut and withdraw cable. Disconnect the engine instruments wiring harness and the engine magneto wiring harness at the connectors at left rear side of engine support beam. Disconnect ground strap from left side of engine support beam.

m. **Remove Oil Temperature Gage Line and Tachometer Drive Cable — Early Models.** On early models, loosen retaining nut and remove oil temperature gage bulb from oil pump finger strainer. Plug the opening. Remove tachometer cable by unscrewing knurled nut. Tie both oil temperature gage line and tachometer cable out of the way.

n. **Disconnect Accelerator Linkage From Carburetor.** Remove the clevis pin from the accelerator rod below the carburetor.

o. **Remove Engine Support Bolts** (fig. 27). Remove the eight bolts (four on each side) that hold the engine support beam to the support brackets. Using special wrench (41-W-906-25), remove the two engine support bolts from engine front supports (one on each side).

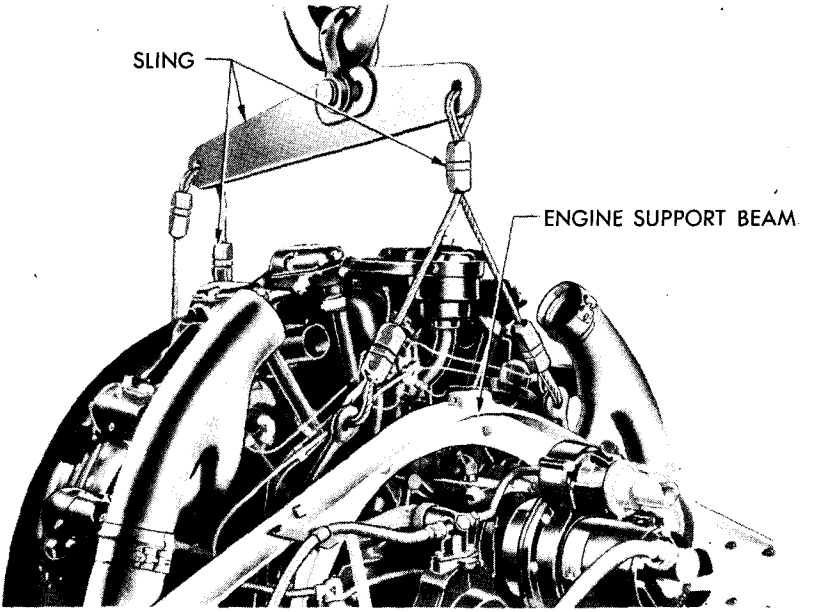


Figure 28 – Engine With Sling (41-S-3832) Attached.

p. Attach Lifting Sling (fig. 28). Suspend the special lifting sling (41-S-3832) from wrecker boom hook over the engine. Slip the sling cable loop over clutch companion flange. Attach one of the two cable hooks at each side of the engine to the support beam.

q. Lift Out Engine. Raise hoist sufficiently to lift engine vertically until it is partially out of engine compartment, taking care to see that no part of the engine catches on any projection in the engine compartment. Rock engine to release the flange from propeller shaft. Have two men on the back of the vehicle hold the engine away from hull. When engine is removed, pull wrecker or hoist ahead and lower engine into a suitable engine stand, putting pipe extensions into steady rest tube if needed, and secure properly. Remove lifting sling.

52. INSTALLATION.

a. Lift Engine into Engine Compartment. Install lifting sling on engine (par. 51 **p**). Free engine from stand. Remove pipe extensions. Raise hoist high enough to clear rear of hull, and move engine over engine compartment. Lower hoist sufficiently to allow engine to be lowered the balance of the way vertically. Have two men at rear of vehicle hold engine clear of any projections in engine compartment. Install steady rest adapters before engine is lowered.

b. Secure Engine to Supports. As soon as engine is in place with support beam seated on the support brackets, and steady rest adapters installed on their brackets, install and tighten the eight bolts, nuts, and cotter pins that hold the support beam in place. Install and tighten engine bolts using special wrench (41-W-906-25) (fig. 27). Remove engine lifting sling.

c. Connect Universal Joint and Companion Flange. Aline the holes in the universal joint and companion flange and install connecting bolts and nuts, tightening them evenly so that the two flanges seat properly. Install lock wire.

d. Connect the Accelerator Linkage. Position the accelerator rod clevis to the throttle lever at the carburetor, and install the clevis pin and cotter pin.

e. Connect the Oil Temperature Gage Line and Tachometer Drive Cable — Early Models. Install oil temperature gage bulb in finger strainer on oil pump and tighten carefully in place. Install tachometer cable on drive connection, tightening knurled nut.

f. Make Electrical Connections — Early Models. Connect magneto ground wires and booster primary wire to their posts in terminal box, threading through top hole in terminal box and connecting, as tagged or otherwise indicated, to the proper terminals. Install and tighten magneto grounds and booster primary conduit connection to terminal box, and install terminal box cover. Install generator wires on terminals inside the shield, replace shield cover, and install and tighten the conduit connection. Install starter cable on cranking motor terminal inside the shield. Replace shield cover, and install conduit connection. Install locking wire through bolt heads or both shield covers. Install and tighten the fuel cut-off solenoid on the bracket on right side of engine support beam, inserting cable in clip on left side of engine support beam, and tightening clip. Connect linkage to fuel cut-off rod by installing clevis over arm, installing clevis pin, and securing with a cotter pin. Connect ground strap on left side of engine support beam.

g. Make Electrical Connections — Late Models (fig. 24). Connect ground strap on left side of engine support beam. Connect the plug and socket of the engine magneto wiring harness. Connect the plug and socket of the engine instruments wiring harness. Install the cranking motor cable on the cranking motor terminal. Secure with a toothed lock washer and nut. Install the terminal housing cover and secure it with locking wire.

h. Connect Oil and Fuel Lines — Early Models. If engine has a breather line from oil tank to engine, pull breather line far enough through bulkhead to connect hose connection at top of engine. Con-

nect other end of breather line at oil tank. Remove covers from oil pressure gage and primer distributor lines, and connect lines below left side of engine. Connect fuel inlet line at fuel pump and fuel by-pass line at three-way elbow on carburetor. Connect oil pump inlet line at "Y" connection for the oil dilution line. Connect oil outlet line and front scavenger line to other "Y" connection.

i. Connect Oil and Fuel Lines — Late Models (figs. 24 and 25). Connect main oil line inlet tube and main scavenger outlet tube to the engine. Connect oil pressure tube from engine to the oil filter. Connect fuel inlet tube to fuel pump. Connect primer distributor line at connection under right side of engine.

j. Install Lower Air Intake Tubes (figs. 24 and 25). Install lower air intake tubes to lower openings in air cleaner housings by means of flexible couplings. Remove cloths from carburetor air horns, slide bellows-type connectors over air horns, and tighten clamps. NOTE: *Make sure connections are airtight.*

k. Install Exhaust Pipes (par. 105).

l. Connect Clutch Release Rod to Clutch Throw-out Bracket Equalizer Yoke. Position rod to yoke, and connect with clevis pin and cotter pin.

m. Install Engine Compartment Floor Inspection Plate. Lift inspection plate into place in floor of engine compartment and secure with a jack. Install cap screws and locking wire in cap screws.

n. Install Engine Compartment Upper Shroud (fig. 23). Insert the two upper air intake tubes into the upper shroud openings. Place the shroud and air intake tubes in position. Attach rear ends of upper air intake tubes to hoses on air cleaners. Install brackets which secure the upper air intake pipes to fuel tank shields. Install bolts, washers, and nuts which secure each side of shroud to fuel tank shields.

o. Install Engine Compartment Front Top Plate. Place the felt seal and joining plate on the upper shroud. Lower the front top plate into place. Install the cap screws and bolts which secure it to the hull and to the upper shroud. Install the rear folding armor plates (par. 160). Install air inlet shutter. Remove sling and eye bolts. On early models, install two fuel shut-off valve handles which project through the guard on the engine compartment from top plate.

p. Install Engine Compartment Rear Top Plate (fig. 23). Install engine compartment front top plate (subpar. **o** above). Hoist the rear top plate and lower it into position. Install the cap screws which secure it to the hull and joining plate. Install the rear exhaust deflector.

q. Inspect for Oil and Fuel Leakage. Turn on the master battery switch and the fuel shut-off valves. Check the engine oil level and add oil if needed. Start the engine and inspect for oil or fuel leaks. Close the engine compartment rear doors when the inspection has been completed.

r. Record Unit Replacement on W.D., A.G.O. Form No. 478. If a new or rebuilt engine assembly has been installed, make the proper entry on MWO and "Major Unit Assembly Replacement Record." See paragraph 2.

Section XV

IGNITION SYSTEM

53. DESCRIPTION.

a. Description (figs. 29 and 30). The engines in the vehicles covered by this manual are furnished with dual ignition from either Bosch or Scintilla magnetos mounted on the accessory case. The two magnetos fire two sets of spark plugs mounted in the front and rear sides of the cylinders. The Scintilla installation, due to design, is supplemented by a booster coil connected through the right-hand magneto to facilitate starting when the engine is cold. The wiring is protected and shielded by metal conduits to minimize radio interference. The control wires for the magneto and booster are connected to a receptacle on the left side of the engine for convenient connection to the switch wires. The spark plugs are aircraft type with single ground electrode which can be cleaned and adjusted.

b. Data.

	Make	Model
Magnetos	Bosch	MJT-9A-306
	or	
	Scintilla	VAG-9-DFA
Booster coil	Auto-Lite	BC 4001

54. MAGNETOS (BOSCH).

a. Adjustment of Breaker Points.

(1) GENERAL. The adjustment of the magneto breaker points must be maintained to insure proper ignition. If the points are badly burned (indicating a faulty condenser) or the fiber blocks on the cam followers are badly worn, replace the magneto.

(2) ADJUST BREAKER POINTS (fig. 31). Open the engine compartment rear doors. Remove the breaker housing cover. Crank the engine by hand to open the points to their widest position, and

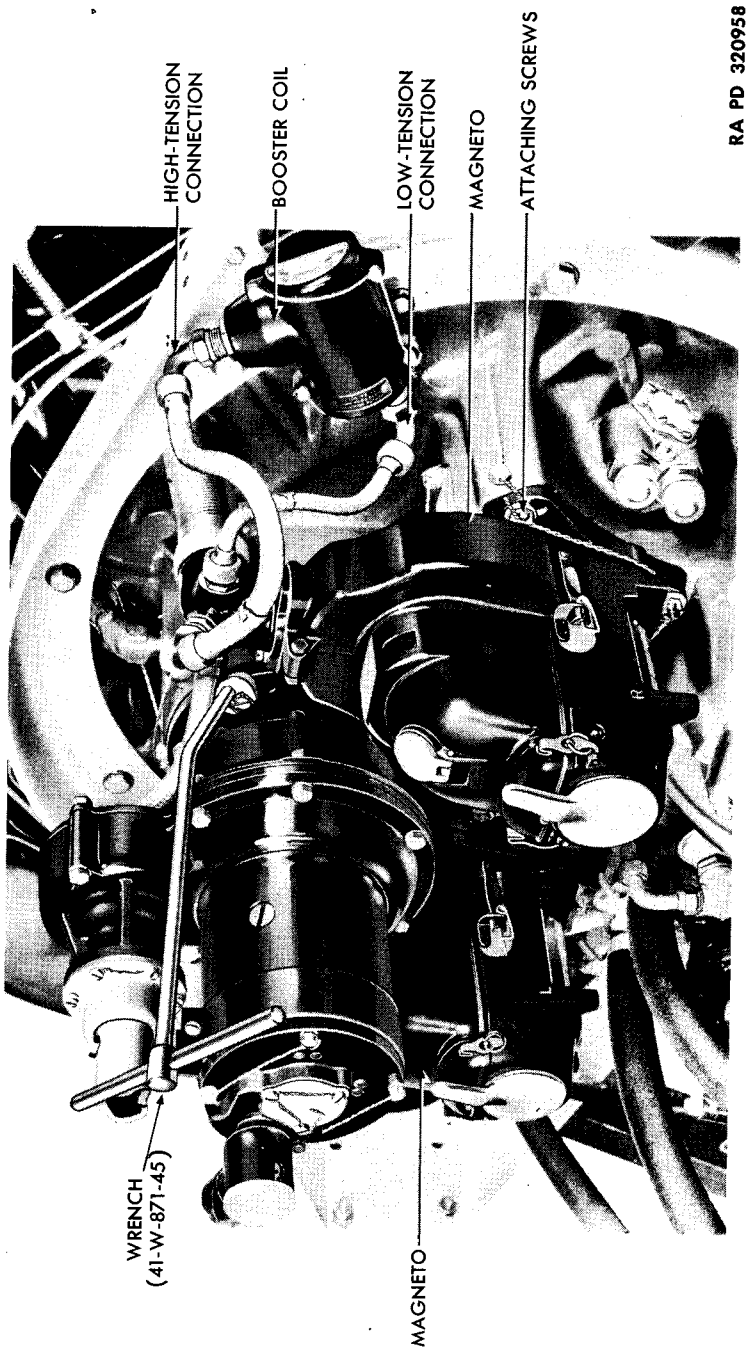


Figure 29 — Right Side of Engine

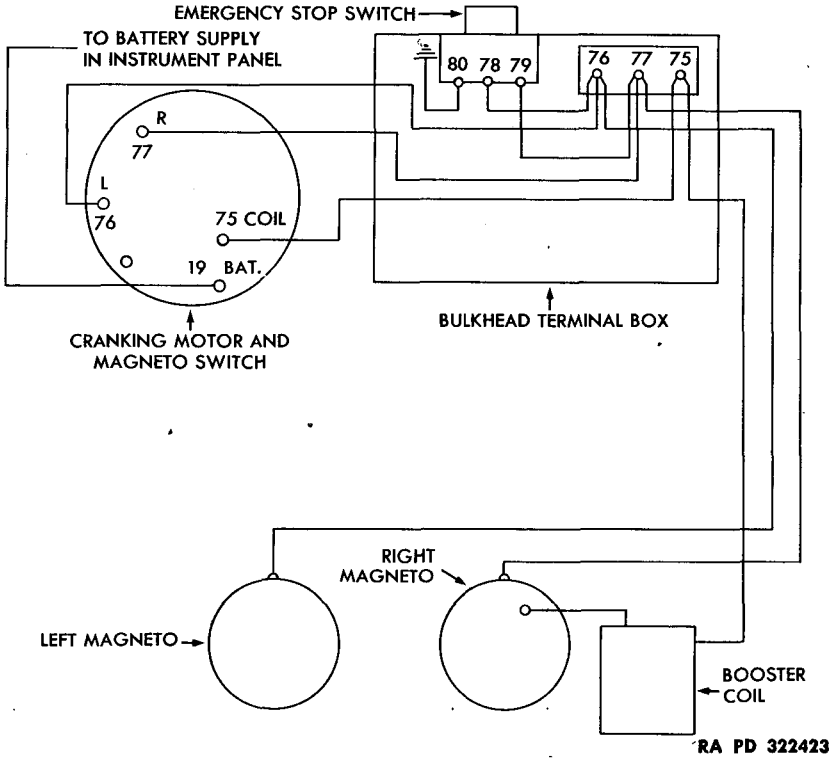


Figure 30 — Ignition System Wiring Diagram

loosen the lock screw which holds the breaker point bracket to the breaker base. Turn the eccentric screw until the gap between the points is 0.008 to 0.010 inch (0.009 inch preferred). Tighten the locking screw. Recheck the gap, and install the breaker housing cover. Close the engine compartment rear doors.

b. **Removal of Magnetos (Engine Out of Vehicle).** Remove and install one magneto at a time, if possible, and use the other magneto to locate the firing position of the engine. When the magnetos are once timed to the engine, this position cannot change unless mechanical failure occurs. CAUTION: *To avoid unnecessary work, do not lose this setting.* If the crankshaft position is changed with both magnetos removed, or maintenance inspections necessitate removal of both magnetos, use the top dead center indicator (41-I-73-110) and timer (41-T-1598) as described in paragraph 56. Remove magneto from engine as follows:

(1) REMOVE DISTRIBUTOR BLOCK (fig. 32). Remove the two screws which hold the conduit elbow to the radio shield cover, and

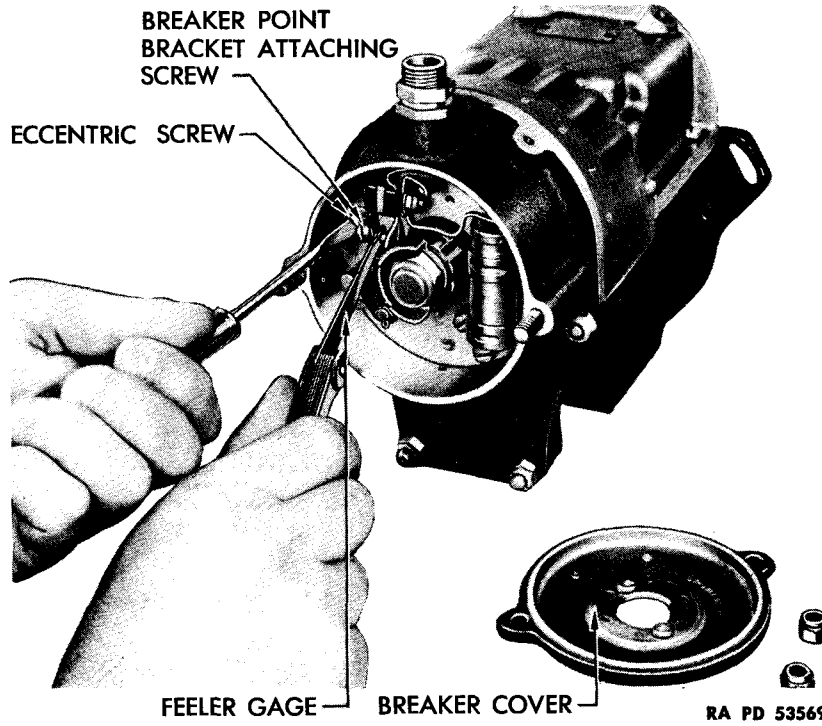


Figure 31 — Adjusting Breaker Point Gap (Bosch)

remove the four screws which hold the cover to the magneto. Remove the four screws which hold the two halves of the cover together, and remove the cover. Remove the two screws from the under side of the distributor block, and remove the block. Disconnect the ground wire.

(2) REMOVE MAGNETO. CAUTION: *If only one magneto is to be removed, make sure that the other unit is grounded. Ground both small contacts in the ignition conduit receptacle, and turn the engine with the hand crank until the red dot on the magneto cam is adjacent to the fiber block on the distributor point, so that the point is just starting to open* (fig. 32). This is the firing position on No. 1 cylinder. Both magnetos will be in the same position. Remove the lock wire and magneto mounting nuts, and remove the magneto. Remove cotter pin, nut, lock washer, and plain washer from magneto governor shaft. Using gear puller (41-P-2941-800), remove splined magneto drive coupling (fig. 35). Tap coupling on new magneto and install plain washer, lock washer, nut, and cotter pin. Install the new magneto as outlined in subparagraph c below, and then remove and install the other unit.

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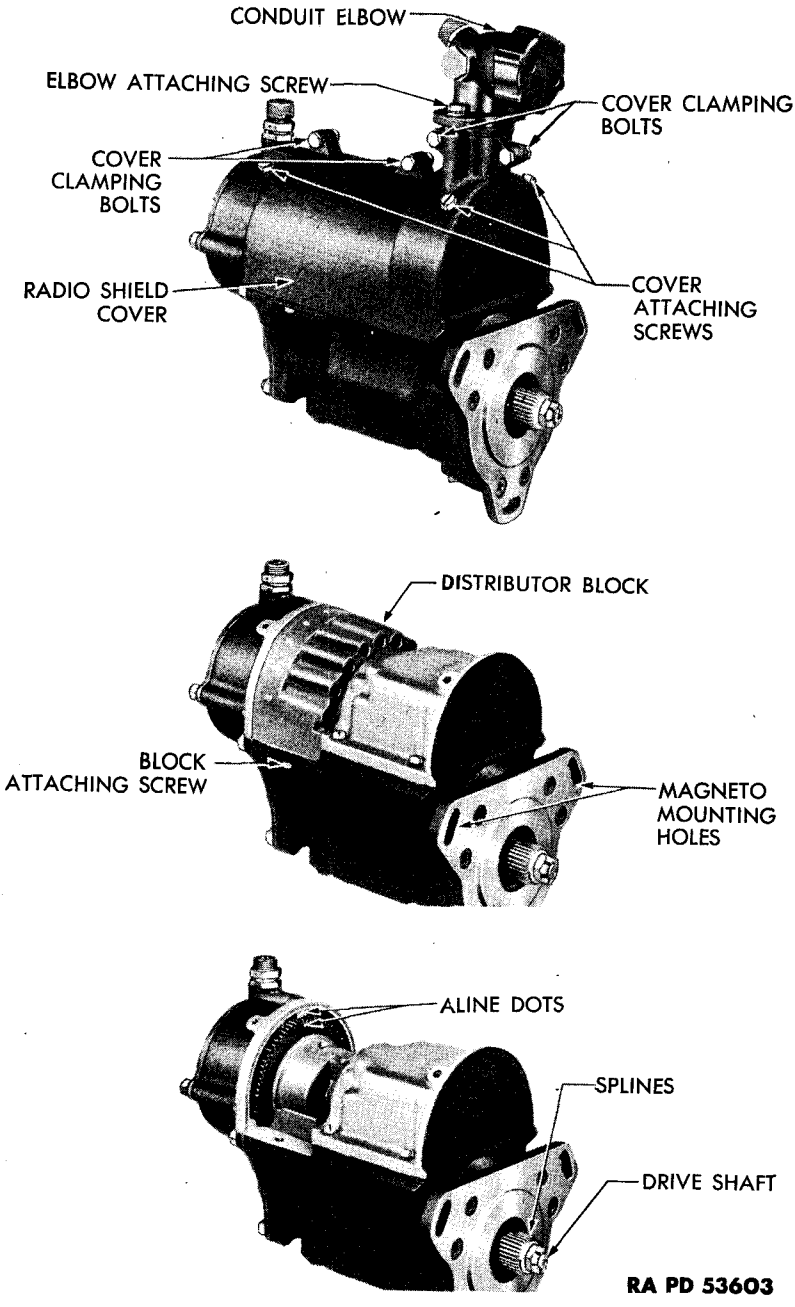


Figure 32 — Magneto (Bosch)

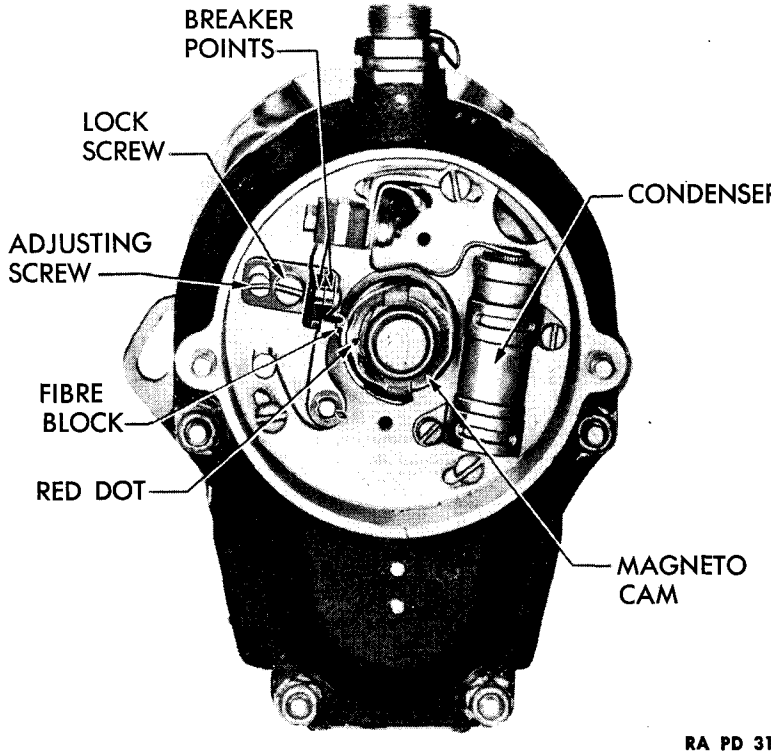


Figure 33 — Timing Position (Bosch)

c. Installation of Magnetos (Engine Out of Vehicle). If a new unit is installed, remove the covers and the distributor block. CAUTION: *The internal timing of the magneto is set when manufactured or overhauled and must not be changed. Do not move the position of the breaker point mounting base.* The points are spaced at 0.008 to 0.010 inch (0.009 inch preferred) on the high point of the cam. This adjustment can be checked if desired, as outlined in subparagraph a (2) above, before installation. Install the magneto on the engine as follows:

(1) INSTALL NEW GASKET. Place a new gasket in position on the mounting studs.

(2) LUBRICATE SHAFT. Apply a small amount of lubricant to the splined end of the magneto shaft.

(3) TIME THE MAGNETO TO ENGINE (fig. 33). Position the red dot on the magneto cam, adjacent to the fiber block on the breaker point arm, so that the dots on the distributor gear and case line up. Hold this position and install the magneto on the engine. Start the

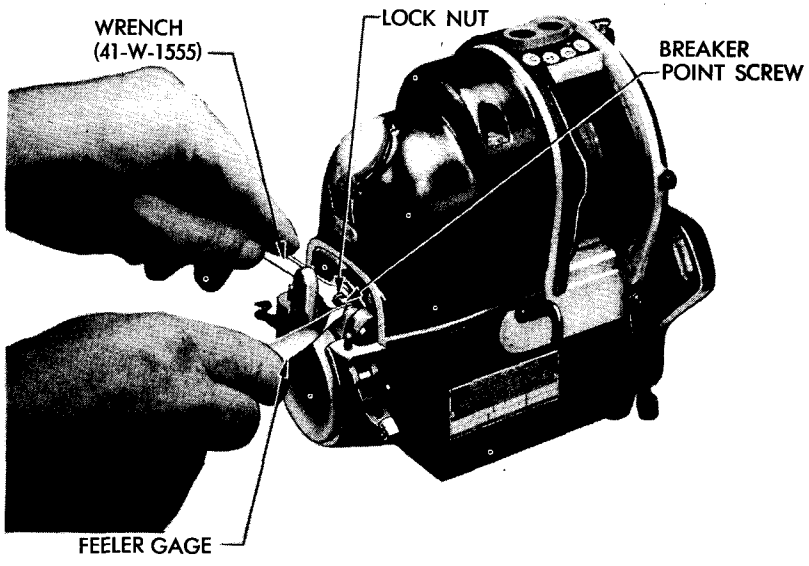
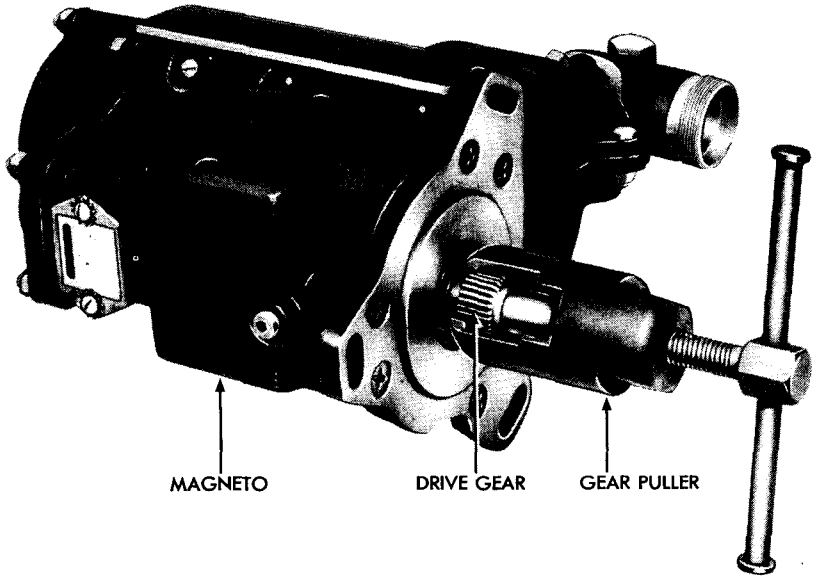


Figure 34 — Adjusting Breaker Point Gap (Scintilla) With Wrench (41-W-1555)

mounting nuts far enough so that the magneto can still be moved on the elongated mounting holes. Place a 0.001-inch feeler gage between the points, and move the magneto until the gage can just be drawn out. Synchronize the magnetos by checking the points in each unit to see that they open at exactly the same time. If only one magneto is replaced, space the points in the other magneto (subpar. a above), and then synchronize the firing of the two units. Tighten the mounting nuts and install the lock wire.

(4) CONNECT WIRING. The numbers on the distributor block which correspond to the numbers taped on the high tension wires indicate the firing order of the magneto. These numbers do not indicate the cylinders to which they are connected. Thus, wire No. 2 is connected to spark plug in cylinder No. 3, as this is the second cylinder to fire in the order of 1-3-5-7-9-2-4-6-8. Connect the high tension wires to the distributor block and connect the ground wire.

(5) INSTALL DISTRIBUTOR BLOCK AND MAGNETO COVERS. Position the distributor block in the magneto and secure with screws. Place the two halves of the magneto cover in place, and start the four screws which attach the cover to the magneto. Start the four screws which hold the two halves of the cover together, and tighten all screws securely. Install the conduit elbow on the cover with the two attaching screws. Install the breaker cover and attaching nuts.



RA PD 320956

Figure 35 — Removing Splined Magneto Drive Gear, Using Special Gear Puller 41-P-2941-800)

55. MAGNETOS (SCINTILLA).

a. Adjustment of Breaker Points.

(1) GENERAL. The adjustment of magneto breaker points must be maintained to insure proper ignition. If the points are badly burned (which indicates a faulty condenser) or the fiber blocks on the cam followers are badly worn, replace the magnetos.

(2) ADJUST BREAKER POINTS (SCINTILLA) (fig. 34). Open the engine compartment rear doors. Remove the safety lock rings, unhook the clamps, and remove the breaker cover. Crank the engine by hand to open the points to their widest position. Loosen the lock nut on the breaker point screw, and adjust the point spacing by turning the screw with wrench (41-W-1555). Space the points to 0.012-inch gap with the gage on wrench. Tighten the lock nut and recheck the gap. Install the breaker cover.

b. Removal of Magnetos (Engine Out of Vehicle). Remove and install one magneto at a time if possible, and use the other magneto to locate the firing position of the engine. When the magnetos are once timed to the engine, this position cannot change unless mechanical failure occurs. CAUTION: *To avoid unnecessary work, do not lose this setting.* If the crankshaft position is changed with both magnetos removed, or maintenance inspections necessitate

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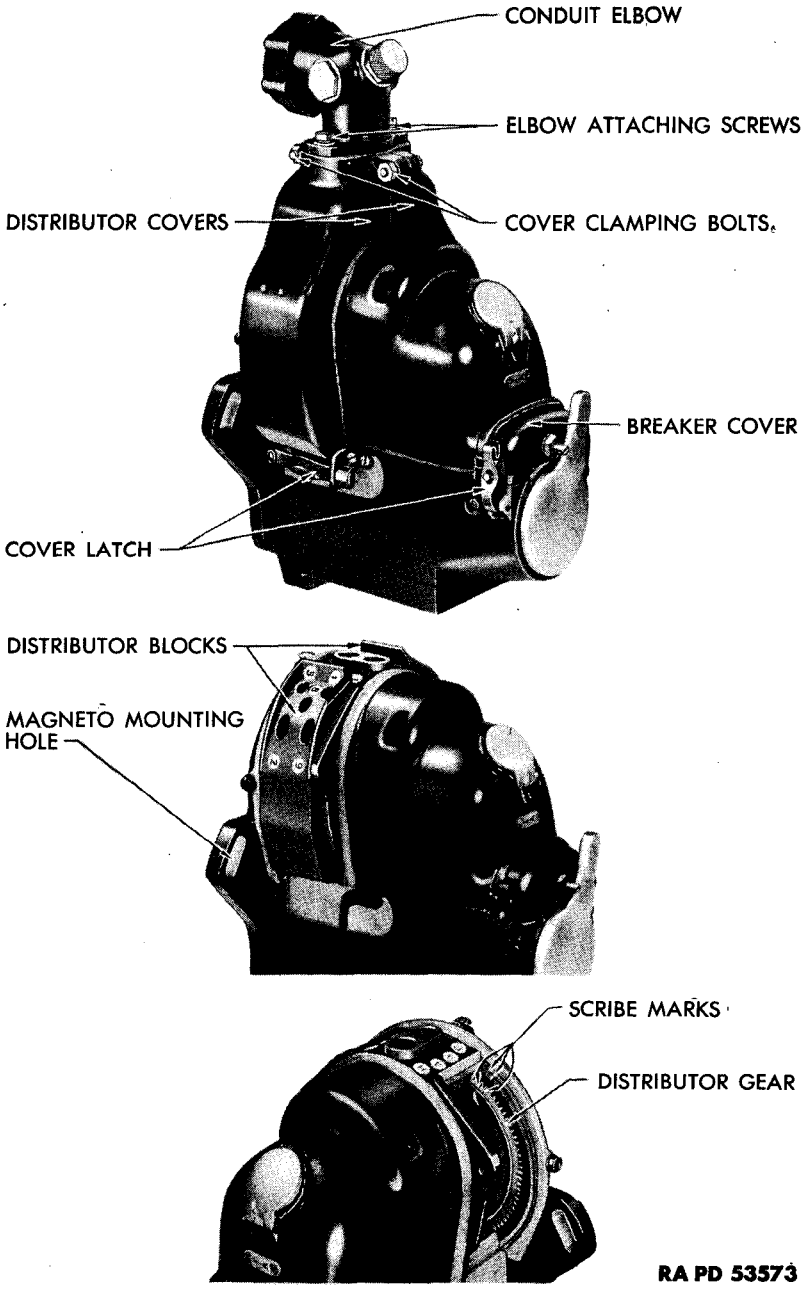


Figure 36 — Magneto (Scintilla)

removal of both magnetos, use the top dead center indicator (41-I-73-110) and timer (41-T-1598) as described in paragraph 56. Remove magneto from engine as follows:

(1) REMOVE BREAKER COVER AND POINTS. Remove the lock wire rings, and unhook the clips which hold the cover over the breaker points. Remove the breaker cover to release the bayonet lock which holds the breaker in the housing. Push the bronze lever to the right. Remove the breaker assembly and spring washer. CAUTION: *Remove the breaker assembly from both magnetos to avoid accidental starting of the engine.*

(2) REMOVE DISTRIBUTOR BLOCK COVERS (fig. 36). Remove the two screws which hold the conduit elbow flange to the top of the cover. Remove the two bolts which clamp the upper ends of the two halves of the cover together. Remove the safety wire pins, unhook the spring latches at the bottom of each half of the cover, and remove the half toward the outside of the vehicle. Loosen the conduit coupling lock rings at the elbow so they will turn. Unscrew the two bakelite connector nuts and disconnect the booster (right magneto) and ground wires from the top of the magneto. Raise the wiring harness, with the distributor blocks attached, far enough to permit removal of the inside half of the cover.

(3) REMOVE MAGNETO. CAUTION: *Remove and install one magneto at a time if possible, so that the other magneto can be used to locate the firing position.* Crank the engine by hand, and aline the two scribe marks on the distributor gear with those on the case, just to the right of the center web of the magneto frame. This is the firing position of No. 1 cylinder. Remove the lock wire and mounting nuts from the flange of the magneto, and remove the magneto.

c. Installation of Magnetos (Engine Out of Vehicle).

(1) TIME ENGINE. If the position of the crankshaft as set for removal (subpar. **b** (3) above) has not been changed, the new unit can be installed by timing the magneto to the engine as described in step (2) below. If the position of the crankshaft has been changed, remove the covers and raise the right distributor block on the other magneto, and crank the engine until the scribe marks line up. This will place No. 1 piston on firing position. Install the new magneto (step (2) below). If both magnetos have been removed and the crankshaft position has been changed, set the engine timing with the top dead center indicator (41-I-73-110) and timer (41-T-1598) as described in paragraph 56.

(2) TIME MAGNETO TO ENGINE (fig. 36). Remove the breaker point assembly and the distributor block from the new magneto. CAUTION: *The internal timing or "E" efficiency gap which is controlled by the two set screws extending through both sides of the*

breaker housing is set when the magneto is manufactured or overhauled. Do not change this adjustment. Place a new gasket on the magneto mounting flange with a small amount of heavy grease to hold it in place. Lubricate the splined end of the magneto rotor shaft slightly. Turn the shaft until the scribe marks on the distributor gear line up with the marks on the housing. Hold this position and mount the magneto on the engine. Tip the magneto from side to side to line up the shaft with the coupling, and start the mounting nuts enough so the magneto can still be moved on the elongated slots in the mounting. Move the magneto as required to perfectly aline the scribe marks, as the points will not be open at this position. Tighten the flange nuts and install the lock wire.

(3) REPLACE DISTRIBUTOR BLOCKS (fig. 36). Loosen the set screws in the distributor blocks, below the contacts which hold the wires into the blocks, and pull out the wires. To install, push the spark plug wires into the holes which are numbered to correspond with the number on the wire. Use a small amount of powdered talc on the wires to prevent fuzing to the block. Tighten the set screws. NOTE: *Install the block with the five wire connections on the left side of the magneto.*

(4) CONNECT GROUND AND BOOSTER WIRES. Place the distributor blocks into position on the magneto, slide the rubber grommet over the ground and booster wire (ground wire only on left magneto). Screw the ground wire into the front hole in the bakelite terminal receptacle on top of the magneto (both magnetos). Screw the booster high tension wire into the rear hole on the receptacle block (right magneto only). Tighten connector screws securely and place the rubber grommet down over the knurled ends of the connectors. CAUTION: *Do not connect the booster to the front contact; this would damage the magneto.*

(5) INSTALL COVERS AND BREAKER POINT ASSEMBLY. Position the distributor block covers on the magneto, and install the two bolts which clamp the top of the two halves of the covers together. Hook the latches at the bottom of the covers, and install the safety pin wires. Install the breaker point assembly, and position the lever of the assembly to the extreme right. Install the breaker point cover, and install the lock wire rings.

56. TIMING ENGINE WITH TOP DEAD CENTER INDICATOR AND TIMER.

a. Time the Engine for Installation of Magneto (Engine Out of Vehicle). If the position of the crankshaft is changed while both magnetos are removed, it will be necessary to ascertain the proper firing position of No. 1 piston before installing the magneto. The

proper firing position is 25 degrees of crankshaft travel before top dead center of the piston for Scintilla magnetos, and 4 degrees before top dead center for Bosch magnetos.

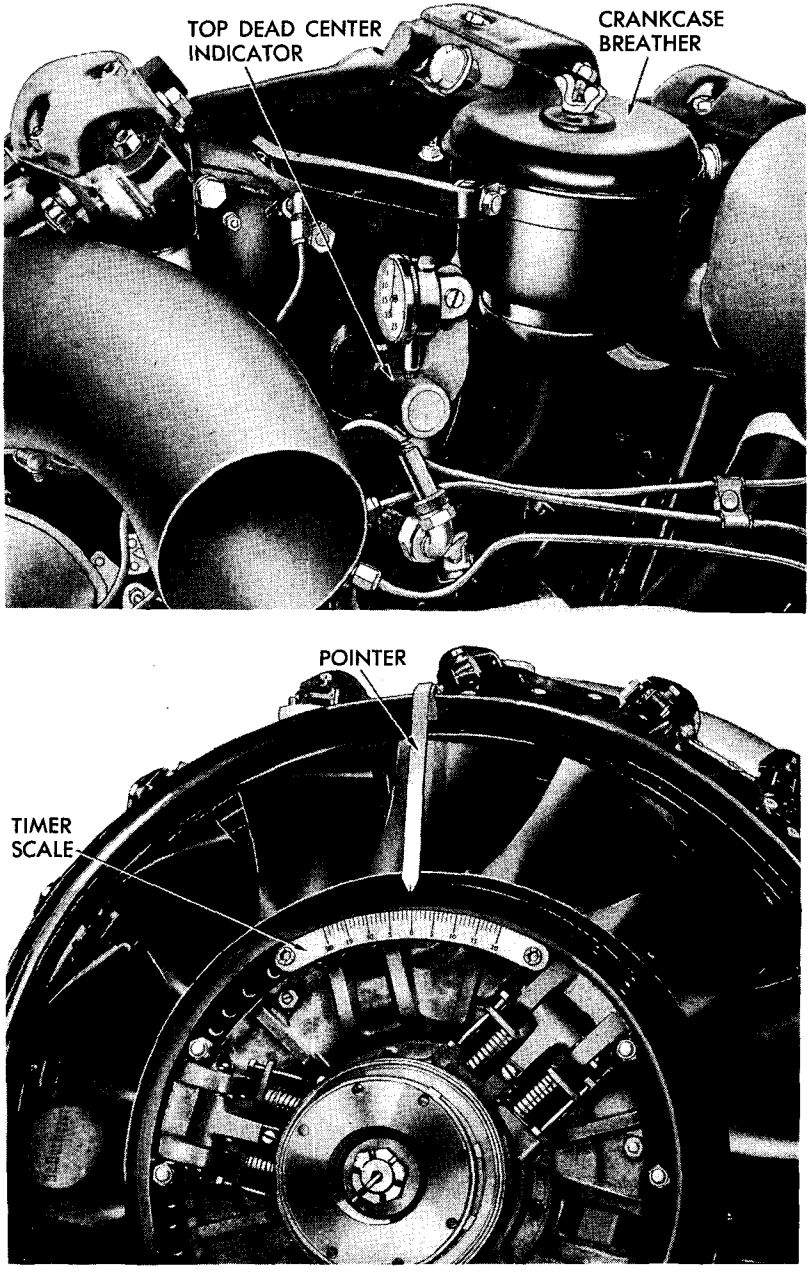
b. Set No. 1 Piston at Top Dead Center (fig. 37). Remove the rear spark plug from No. 1 cylinder and feel for an exhaust of air from the spark plug hole while the engine is cranked by hand. When the compression stroke is indicated by air forced from the cylinder, install the top dead center indicator (41-I-73-110). Continue to crank the engine until the dial gage indicates that the piston is operating the indicator; then crank very slowly until the indicator hand stops. The piston will then be at top dead center.

c. Set Firing Position (fig. 37). Attach the timer scale (41-T-1598) on the clutch bolts and the pointer on the cowling. Position the pointer so that it points to zero on the scale. The timer will then indicate the top dead center position of No. 1 piston, and the scale attached to the clutch will indicate degrees of crankshaft travel. Turn the engine in the reverse direction with the fan blades (clockwise when facing flywheel) approximately ¼ turn to avoid error due to lash in timing gears. Then turn the flywheel slowly in the direction of rotation until the timer pointer indicates 4 degrees ahead of zero on the timer scale (Bosch magneto), or 25 degrees ahead of zero (Scintilla magneto). This is the firing position of No. 1 piston. NOTE: *The scale is graduated 20 degrees on each side of the zero. When using the scale on Scintilla equipped engines, make an additional scribe mark indicating 25 degrees to the right of the zero.*

d. Timing Values. R975-C1 engines with serial numbers lower than 310,000 have the old timing values on the name plate. If the old timing values have not been changed, obliterate them and stamp on the new timing values.

57. FIELD REPLACEMENT OF MAGNETOS AND EMERGENCY ADJUSTMENTS.

a. Field Replacements. Do not attempt to substitute one make of magneto for another when making field replacements as the wiring is different for the two installations. The magnetos can be replaced in the field, working through the engine compartment rear doors in exactly the same manner as outlined in paragraph 54 (Bosch) and paragraph 55 (Scintilla). CAUTION: *Do not remove both magnetos at the same time or lose the firing position as the top dead center indicator and timer cannot be used with the engine in the vehicle.* Synchronize the two Bosch magnetos so that they fire at the same time or perfectly aline the scribe marks on both Scintilla



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Figure 37 — Timing Fixture and Top Dead Center Indicator

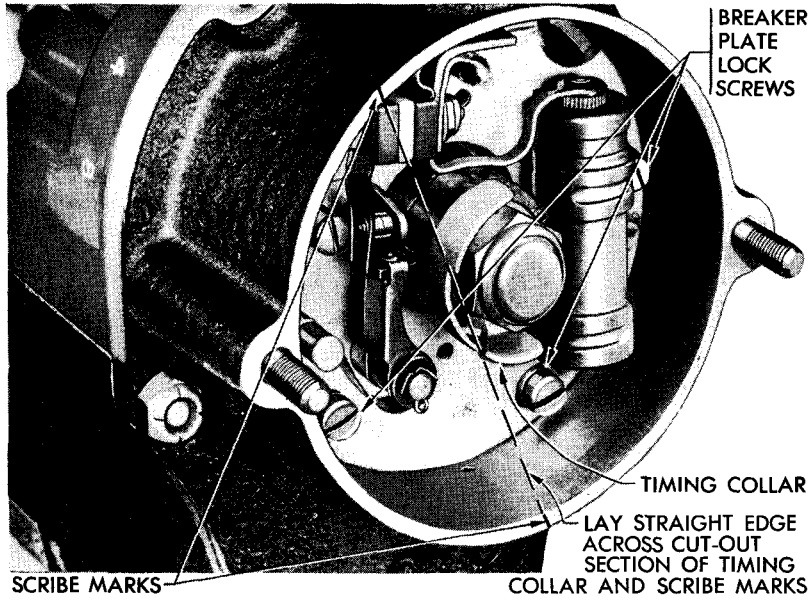


Figure 38 — Alining Timing Collar and Scribe Marks (Bosch)

magnetos. NOTE: *Check the engine timing with gage at earliest opportunity.*

b. Replace Points and Set "E" (Efficiency) Gap.

(1) BOSCH. In an emergency the contact points and condenser can be replaced if the parts are available. This will necessitate setting the "E" (efficiency) gap so that the points open in the proper relation to the position of the magneto rotor. Replace and space the points 0.009 inch, and position the cam with the dot adjacent to the fiber block on the cam follower. Place a scale or straight-edge across the cut-out in the guard on the cam so that the scale indexes with the notches in the breaker housing, as shown in figure 38. Loosen the three breaker base screws, and shift the base assembly so that the points just start to open (0.001-inch gap). Tighten the breaker base. NOTE: *Check the engine timing with gage at earliest opportunity.*

(2) SCINTILLA. The breaker and point assembly (SCI-2-841) is furnished for the Scintilla magneto, and an emergency replacement can be made. Install and space the new points 0.012 inch. Do not attempt to alter the "E" (efficiency) gap setting as the allowable tolerance in timing the unit will permit satisfactory performance until the magneto can be replaced and the timing properly checked.

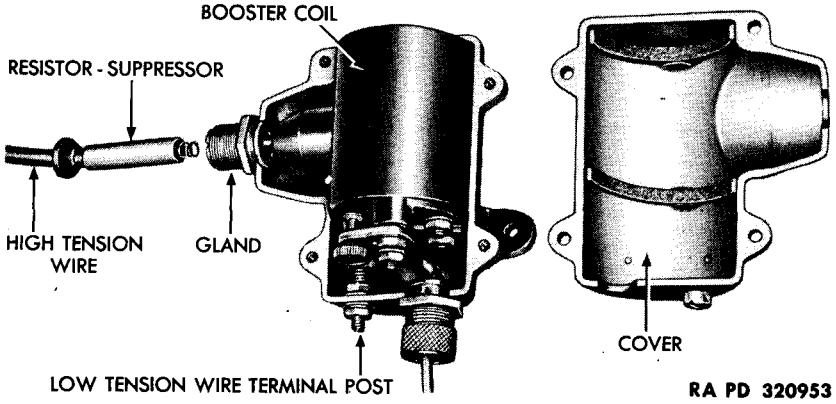


Figure 39 — Booster Coil Assembly

58. BOOSTER COIL.

a. Description. The booster coil is a vibrator-type high tension induction coil supplementing the Scintilla magneto ignition, to facilitate starting when the engine is cold. The output of the coil is connected through the right-hand magneto and trails," or is later than the magneto ignition. The action of the booster increases engine speed to assist in reaching the cut-in speed of the magneto.

b. Removal (figs. 29 and 39). Loosen the high tension shielding connection from the booster. Remove elbow nut, and pull out the resistor suppressor from the coil. Remove coil from engine support beam. Disconnect coil from low tension lead by removing cover screws, and disconnecting low tension lead terminal from inside the coil.

c. Installation (figs. 39 and 29). Connect low tension lead terminal to booster coil terminal post. Install booster coil cover screws and lock wire. Place booster coil on engine support beam, and install attaching bolts. Insert high tension radio suppression resistor suppressor into coil, and tighten elbow nut. Tighten shielding nut to elbow fitting.

59. SPARK PLUGS.

a. Description and Data.

(1) DESCRIPTION. The spark plugs are the regular aircraft type with single ground electrode. Gaskets are furnished with the plugs. With the engine in the vehicle, the five upper front spark plugs can be removed and installed through the air inlet shutter opening. The five upper rear spark plugs can be removed and installed through the rear engine compartment doors. The four lower front

and four lower rear spark plugs can be removed and installed through the inspection plate opening in the engine compartment floor.

(2) DATA.

Manufacturer	Champion
Type	CP63S
Spark plug gap	0.017 to 0.019 in.

b. Removal. Remove air inlet shutter (par. 156) and engine compartment inspection plate. Remove inspection plates from engine cowl. Loosen the nut that attaches the radio shielding to the conduit elbow. Unscrew the conduit elbow nut from the top of the spark plug, and pull out resistor suppressor from the spark plug. Remove spark plug with a socket wrench.

c. Installation. Install the solid copper gasket. Apply a thin coating of mica base antiseize compound to the threads of the spark plug, and install the plug in the cylinder. Tighten the plug with a socket wrench, to 28 to 30 foot-pounds tension. Insert the ignition wire connection into the spark plug. Tighten the conduit elbow nut and the nut attaching the radio shielding to the elbow. Install the inspection plates in the engine cowl. Install the air inlet shutter (par. 156), and the engine compartment inspection plate.

Section XVI

FUEL SYSTEM

60. DESCRIPTION.

a. Fuel Supply System. Fuel is supplied to the carburetor at a pressure of approximately 3½ pounds. The fuel travels from the vertical fuel tanks through built-in filters to shut-off valves, and then is drawn up into the fuel pump located above the carburetor. The fuel pump forces the fuel to the carburetor.

b. Priming System. A fuel tube connects the left fuel valve to the priming pump. Fuel drawn into the priming pump by the operation of the pump plunger is forced to the priming distributor and through the tubes into the top seven cylinders of the engines.

61. CARBURETOR.

a. Description.

(1) The carburetor (G-163-01-31450) is attached to the rear of the engine. Gasoline and air are mixed in the carburetor before entering the supercharger housing. Adjustments are provided for engine idling speeds and for idling fuel mixture.

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

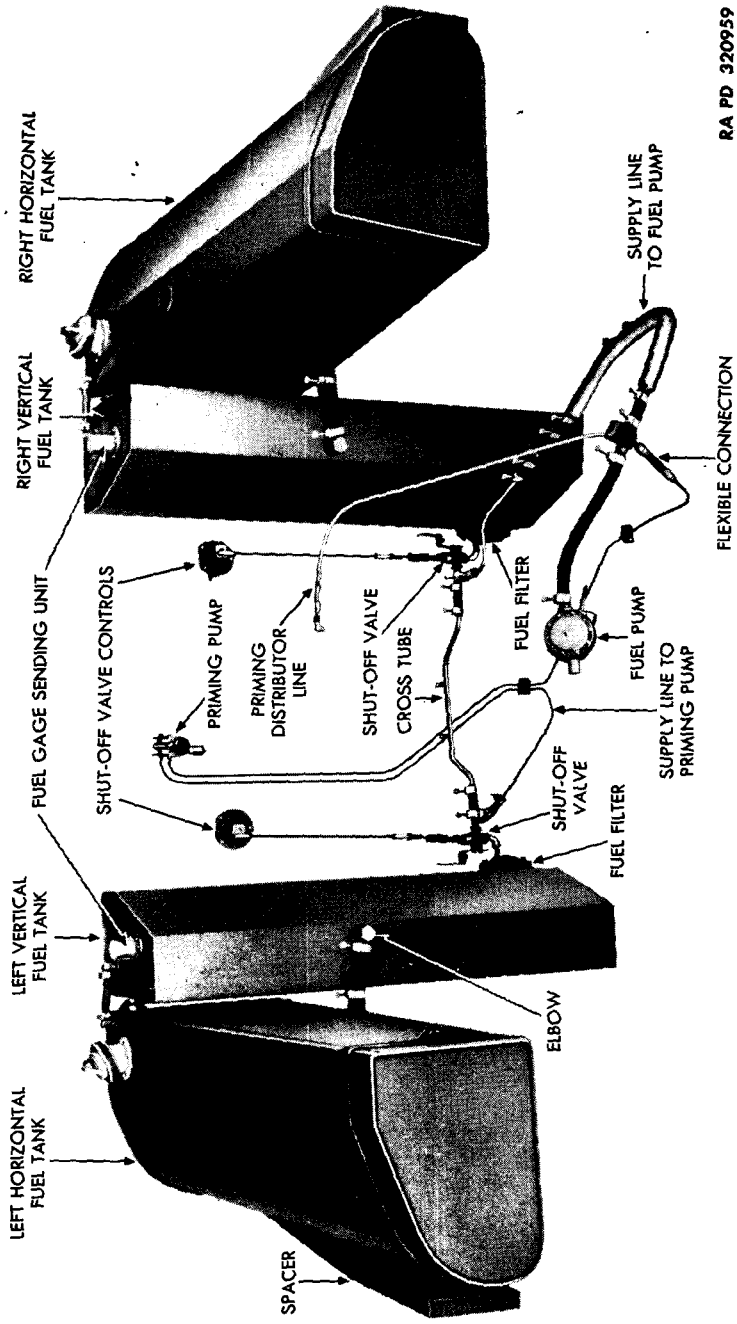


Figure 40 — Fuel System

(2) When the clutch pedal is in the fully released position, the normal engine idling speed of 800 revolutions per minute is controlled by adjustable linkage between the clutch release cross shaft and the accelerator cross shaft. When the clutch pedal is depressed, the idling linkage at the cross shafts becomes inoperative and the engine idling speed is then controlled by the idling adjustment screw at the top right side of the carburetor. The idling adjustment screw may be adjusted to allow a lower idling speed when shifting transmission gears.

b. Adjustment of Engine Idling Speed (Vehicles With High Idle Linkage.

(1) ADJUST NORMAL IDLING SPEED. With the engine running at normal operating temperature and the clutch pedal in engaged position, adjust the hi-idle linkage at the cross shafts below the driver's seat (fig. 49) so that the engine will idle at 800 revolutions per minute.

(2) ADJUST LOW IDLING SPEED. After the normal idling speed adjustment has been made (step (1) above), hold the clutch pedal in the depressed position and adjust the idle speed adjustment screw at the carburetor so that the engine will idle at approximately 500 revolutions per minute.

c. Adjustment of Engine Idling Speed (Vehicles Without High Idle Linkage). On these vehicles, the position of the clutch pedal does not affect the idle speed. Adjust the idle speed adjustment screw at the carburetor so that engine will idle at approximately 500 revolutions per minute.

d. Adjustment of Idling Fuel Mixture. The idling fuel mixture adjustment lever is located in the center and to the top of the carburetor. Push the lever to the right to lean the mixture, or to the left to enrich the mixture.

e. Drain Plugs and Strainer (figs. 41 and 42). Two drain plugs are located in each float chamber. Remove the plugs to drain the chamber. The fuel strainer is located at the bottom left side of the carburetor. Remove the plug in the bottom of the strainer housing to take out the screen for cleaning.

f. Removal of Carburetor (figs. 41 and 42). Close fuel tank valves. Disconnect the clamps from the bellows-type flexible couplings at the lower end of the air intake tubes, and remove couplings from the air horns. Cover the air horn openings. Disconnect the fuel tube at carburetor. Disconnect oil drain tube at the governor and at the fuel pump elbow. Remove cotter pin and clevis pin from the governor arm and the cotter pin from throttle rod. Unscrew knurled nut and disconnect lead at the idle fuel cut-off valve. Take

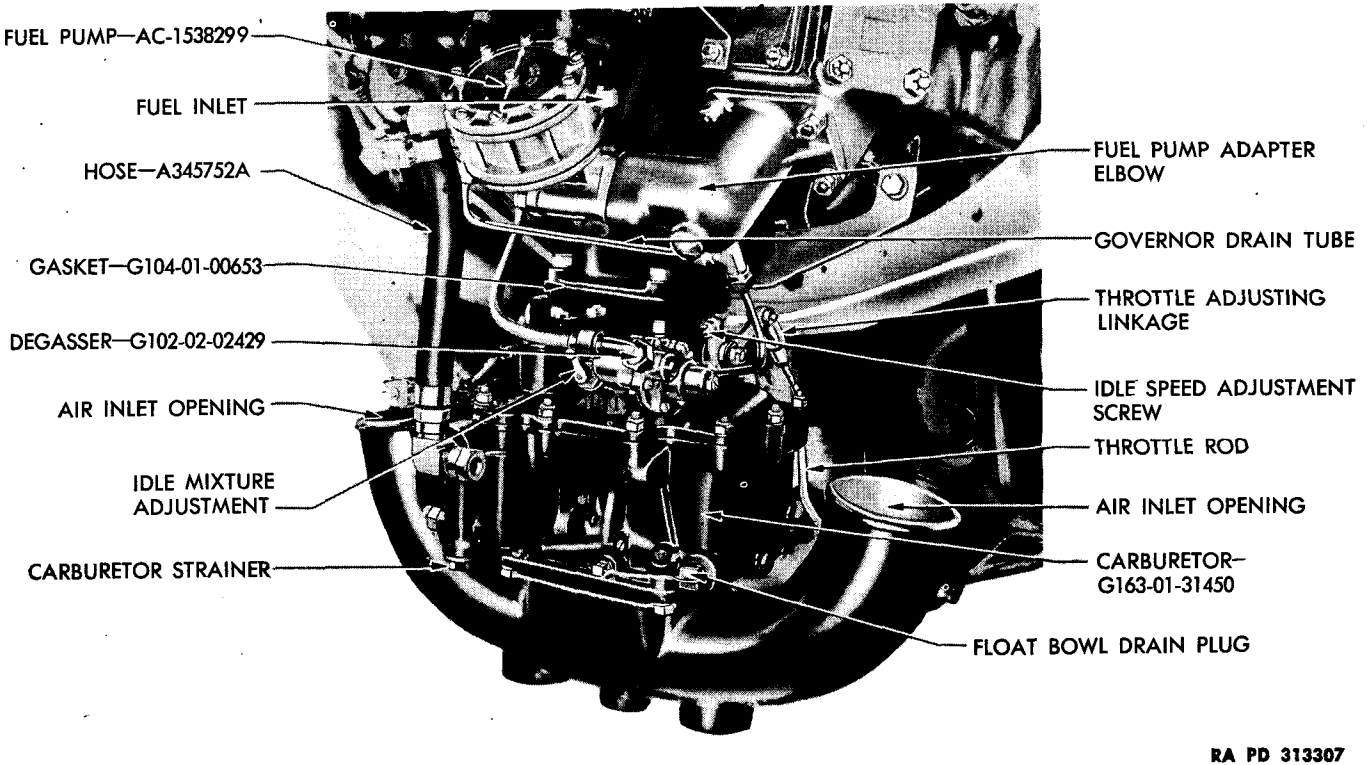


Figure 41 — Right Side of Carburetor

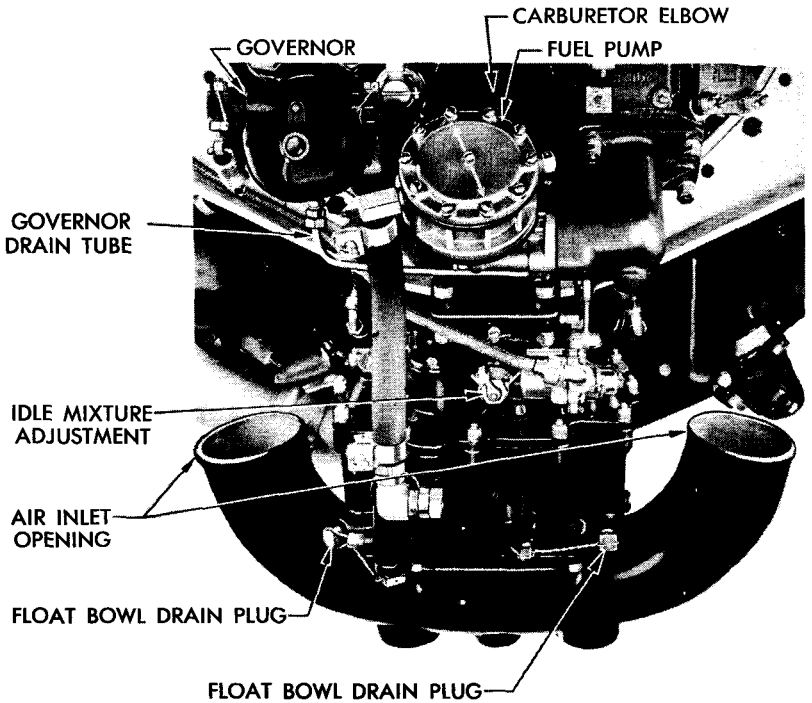


Figure 42 — Rear View of Carburetor

out the bolts which hold the carburetor to the throttle box. Tilt the carburetor toward the doors and lift it out.

g. **Installation of Carburetor** (figs. 41 and 42). Place a gasket (G-104-01-00653) on the carburetor flange and attach the assembly to the governor throttle box. Position the accelerator rod and secure with cotter pin. Position the governor arm and secure with clevis and cotter pin. Connect the oil drain tubes to the governor and fuel pump elbow. Connect the fuel inlet hose (CWR-203025) to the carburetor. Connect the lead wire at idle fuel cut-off valve, and tighten knurled nut in place. Uncover air horn openings. Place the air intake bellows couplings over the ends of the air horn, and tighten clamps in place. Open fuel tank valves. Check for leaks and adjust carburetor (subpars. **b** and **c** above).

62. FUEL PUMP.

a. **Description.** The fuel pump (fig. 41) is mounted to the accessory case above and to the right of the carburetor. The pressure is regulated at approximately 3½ pounds.

b. Replacement. Disconnect the inlet and outlet tubes to the fuel pump. Disconnect the oil drain tubes from the governor and fuel pump body. Remove the nuts that hold the fuel pump body to the accessory case, and remove the fuel pump. To install, place new gasket (G-103-15-93607) in position and install the fuel pump (AC-1538299) and attaching nuts. Connect the oil drain tubes and the inlet and outlet tube.

63. FUEL TANKS, LINES, AND FILTERS.

a. Description and Data.

(1) DESCRIPTION. The four fuel tanks have a total capacity of 176 gallons. Two 30-gallon vertical tanks are located in the front corners of the engine compartment, and two 58-gallon horizontal tanks are located one on each side of the engine compartment on the sponsons. A fuel filter is installed into the side of each vertical tank, and a fuel shut-off valve is screwed into each filter flange. A cross tubing connects the right and left tanks through the two shut-off valves. The fuel filter elements (B201146) are of the full-flow type, and cannot be cleaned unless the filter is removed from the vehicle.

(2) DATA.

Fuel filters:

Manufacturer ..... AC Spark Plug

Shut-off valve:

Manufacturer ..... Imperial Brass Mfg. Co.

b. Draining Fuel Tanks. Remove left hull plug (fig. 161). Reach through opening and unscrew drain plug from left vertical fuel tank. Drain left tanks. Drain right tanks in similar manner.

c. Removal of Vertical Fuel Tanks.

(1) DRAIN TANKS (subpar. b above).

(2) REMOVE ENGINE (par. 51).

(3) REMOVE LOWER ENGINE SHROUD. Remove screws from lower engine shroud and shroud seal. Lift out shroud and shroud seal.

(4) DISCONNECT FUEL, FIRE EXTINGUISHER, OIL, AND ELECTRICAL LINES IN WAY OF FUEL TANK SHIELD. Remove fire extinguisher front nozzle, and tube sections on each side of nozzle. NOTE: *For left vertical fuel tank, remove oil tubes between engine oil cooler and by-pass valve.* Disconnect wire from fuel gage sending unit. Loosen wiring harness connections. Disconnect tube from top of vertical tank. Loosen tube clamps from supply tube between horizontal tank and vertical tank elbow. Unscrew elbow from tank.

(5) REMOVE FUEL FILTER (subpar. g below).

(6) DISCONNECT TANK. From under subfloor of crew compartment, back off tank hold-down screws. Remove tank bracket and holding plate. Remove cap screws securing fuel gage flange to top of fuel tank. Loosen cap screws which secure tank shield.

(7) LIFT OUT TANK. Improvise a tank lifting sling by tieing a short bar at one end of a rope or cable and a longer lifting bar at the other end. Insert shart bar through opening in top of tank. Pull it up against the under side of top of tank. Lift tank from pocket.

d. Installation of Vertical Fuel Tanks.

(1) POSITION TANK. Lift vertical fuel tank in position in pocket with the aid of lifting sling (subpar. **c** (7) above). Tighten cap screws in tank shield. Place tank shims and spacers around upper part of tank. Drive the shims and spacers down flush with top of tank, and make sure tank is firmly wedged. From under rear subfloor in crew compartment, tighten tank hold-down screws securely and set jam nuts. Place holding plate and tank bracket on top of tank, install bolts, and tighten set screw and jam nut. Insert fuel tank gage sending unit in vertical tank. Install attaching screws which secure sending unit flange to top of fuel tank.

(2) INSTALL FUEL FILTER (subpar. **h** below).

(3) CONNECT FUEL, FIRE EXTINGUISHER, OIL, AND ELECTRICAL LINES. Screw supply tube elbow in vertical tank, and connect supply tube from horizontal tank to elbow. Tighten tube clamps. Connect tube from top of horizontal tank to vertical tank. Attach wiring harnesses to tank shield with clips, and tighten all harness connections. Connect wire to fuel gage sending unit terminal on top of tank. On left vertical tank, position tubes between engine oil cooler and by-pass valve. Tighten tube clamps. Position the front fire extinguisher nozzle and the tube sections on each side of it. Install tube bracket screws and tubing clip.

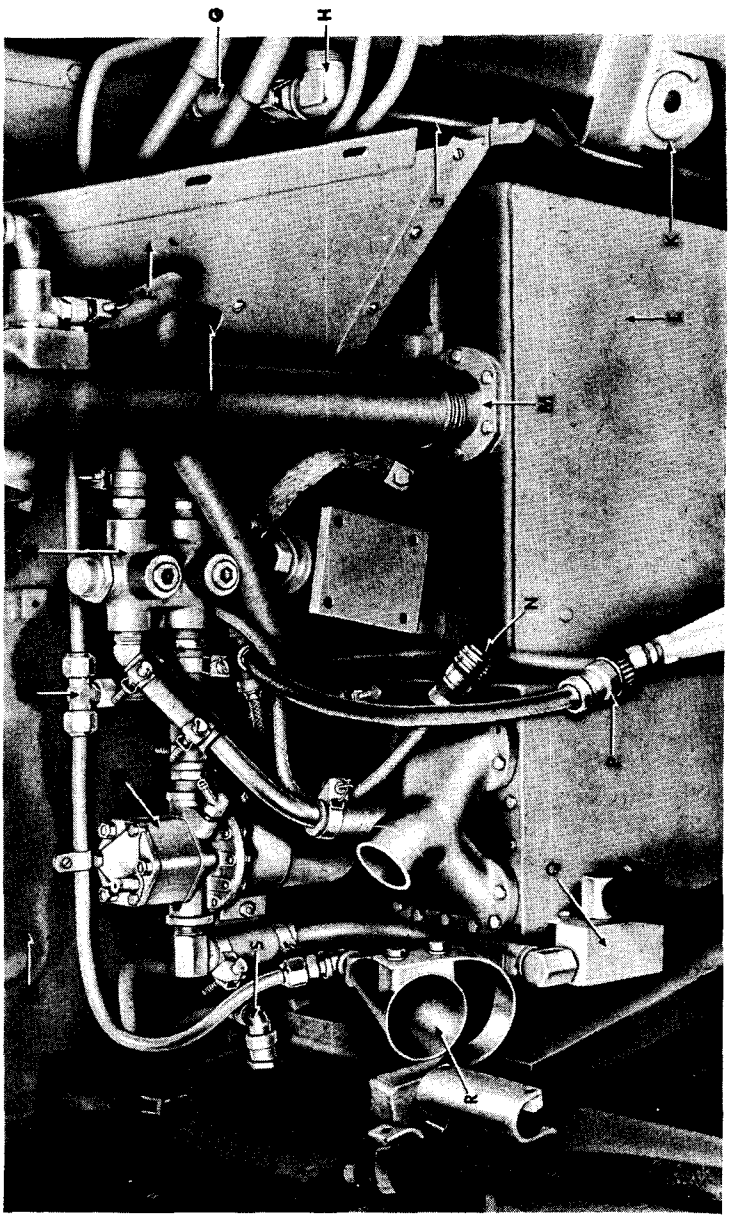
(4) INSTALL LOWER ENGINE SHROUD. Position the shroud seal, and lower engine shroud. Install cap screws and lock washers.

(5) INSTALL ENGINE (par. 52).

e. Removal of Horizontal Fuel Tanks.

(1) REMOVE VERTICAL FUEL TANKS (subpar. **c** above).

(2) DISCONNECT FIRE EXTINGUISHER, OIL, AND ELECTRICAL LINES IN WAY OF FUEL TANK SHIELD. From left side of engine compartment, remove tubes from oil filter. Remove oil temperature control from fuel tank shield and lay it aside. Remove oil filter. Remove oil filter assembly and lay it aside. Cover oil supply tank opening with a cloth. From left and right side of engine compartment, unscrew fire extinguisher tubing connections and remove tube in sections. Disconnect wiring harness and taillight connector. Re-



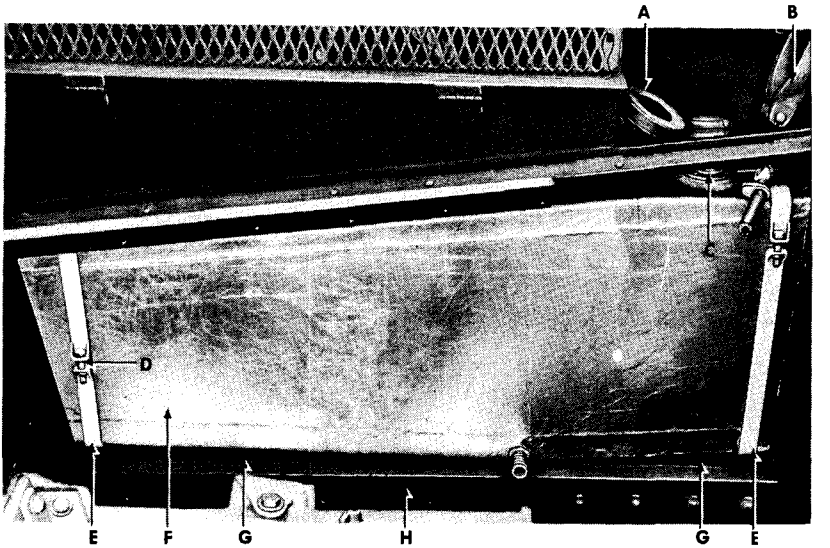
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Figure 43 — Engine Compartment Left Side — Engine Removed

A—HORIZONTAL FUEL TANK SHIELD
B—OIL FILTER
C—FIRE EXTINGUISHER LINE TEE
D—BY-PASS VALVE
E—LOWER ENGINE SHROUD SEAL
F—LOWER ENGINE SHROUD
G—HORIZONTAL TO VERTICAL FUEL TANK SUPPLY TUBE
H—ELBOW
J—FIRE EXTINGUISHER LINE
K—ENGINE FRONT SUPPORT BRACKET
L—OIL SUPPLY TANK
M—FILLER PIPE FLANGE
N—ENGINE MAGNETO WIRING HARNESS CONNECTOR
P—ENGINE INSTRUMENTS WIRING HARNESS CONNECTOR
Q—DISTRIBUTION BLOCK
R—FIRE EXTINGUISHER NOZZLE
S—LEFT TAILLIGHT WIRING HARNESS

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Legend for Figure 43



A—WASHER AND SPACER ASSEMBLY
B—COVER
C—FILLER NECK
D—RETAINING STRAP SCREW
E—RETAINING STRAP
F—LEFT HORIZONTAL FUEL TANK
G—SPACER
H—LEFT SPONSON

RA PD 320925

Figure 44 — Left Horizontal Fuel Tank Installed

move clips which secure wiring harnesses to fuel tank shield. Loosen all harness connections and lay harness to one side.

(3) REMOVE FUEL TANK SHIELDS (fig. 43). Remove cap screws and bolt securing vertical fuel tank shield, and lift out shield. Remove cap screws and bolts securing horizontal fuel tank shield, placing one man on outside of vehicle to hold bolts. Lift off shield.

(4) REMOVE TANK (fig. 44). Open fuel cap cover and lift out washer and spacer assembly from filler neck. Remove filler neck flange screws, and lift out filler neck assembly. Remove nuts from retaining straps. Bend straps out so that tank can be removed. Pull out tank. Remove tank shims and spacers.

f. Installation of Horizontal Fuel Tanks (fig. 44).

(1) POSITION FUEL TANK. If bottom and outside spacers have been removed, place them in left rear sponson. Place the fuel tank in position on the spacers, and bend the attaching straps into place. Install screws and nuts in attaching straps. Place the filler neck in position, and install the flange screws. Install the washer and spacer assembly and close the fuel cap cover.

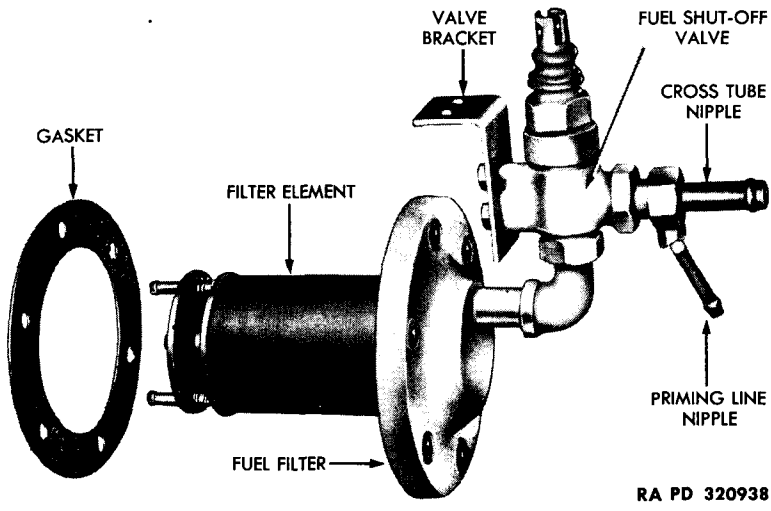


Figure 45 — Fuel Filter and Fuel Shut-off Valve

(2) INSTALL FUEL TANK SHIELDS. Place the horizontal fuel tank shield in position. If spacers attached to shield are damaged, replace them with new ones. Install cap screws and bolts securing horizontal fuel tank cover, with man outside the vehicle to hold the bolts. Place the vertical fuel tank shield in position, and install cap screws and bolt which secures it.

(3) INSTALL THE VERTICAL TANK IN POCKET (subpar. d above).

(4) INSTALL FIRE EXTINGUISHER, OIL, AND ELECTRICAL LINES. Position the wiring harnesses, and attach them to fuel tank shield. Tighten harness connections. Attach the wiring harness connector to the taillight. Place the fire extinguisher tubes in position and connect them. On left side of engine compartment, attach oil temperature control to fuel tank shield. Attach oil filter to fuel tank and tighten attaching cap screws. Install tube between oil filter and oil temperature control. Install oil filter to distribution block tube. Install oil filler assembly on oil supply tank.

(5) INSTALL ENGINE (par. 52).

g. Removal and Cleaning of Fuel Filters. Remove fuel shut-off valve (subpar. i below). Remove cap screws and lock washers securing fuel filter flange to fuel tank, and lift out fuel filter. **NOTE:** *Do not disassemble the filter.* Clean filter elements in dry-cleaning solvent.

h. Installation of Fuel Filters. Place the fuel filter in fuel

tank opening, with gasket in position, and install lock washers and cap screws. Install shut-off valve (subpar. j below).

i. **Removal of Fuel Shut-off Valves.** Drain fuel tanks (subpar. b above). Remove inspection plate in engine compartment floor. Disconnect priming line tube (left fuel filter only) and cross tube from fuel shut-off valve. Disconnect fuel valve control rod from valve. Unscrew shut-off valve from filter flange.

j. **Installation of Fuel Shut-off Valves.** Screw shut-off valve into fuel filter. Connect valve control rod to valve. Connect priming tube (left fuel filter only) to left shut-off valve. Connect cross tube to fuel shut-off valves. Install inspection plate in engine compartment floor (par. 52 m). Check valves for leaks with a small amount of fuel in tanks before filling tanks completely.

k. **Replacement of Fuel Shut-off Valve Control Assembly.** Remove the cotter pin and disconnect control rod ball joint on the engine side of the bulkhead. Take out the flange screws and remove shut-off valve control assembly from crew compartment side of bulkhead. To install, position the assembly and attach to bulkhead. Connect and replace cotter pins in control rod ball joint.

l. **Replacement of Fuel Tubes** (fig. 40). When fuel tubes are replaced, bend the new tube to conform to the shape of the old tube. Cover the supply line to the fuel pump with insulation at right rear of engine compartment to protect it from engine heat.

64. FUEL GAGE SENDING UNITS.

a. **Description** (fig. 80). The fuel gage sending units are installed, one in each vertical fuel tank, and are connected electrically to the selector switch in the instrument panel. The selector switch connects the sending units to a fuel gage on the instrument panel (fig. 8) which indicates the amount of fuel in either the right or left tanks when the switch is operated.

b. **Removal.** Remove the engine compartment front top plate (par. 51 c). Disconnect the fuel gage sending unit wire from the sending unit. Remove the cap screws which secure the sending unit flange to the top of the fuel tank. Lift out the sending unit from the tank. Cover the opening in the tank with cloth.

c. **Installation.** Insert the sending unit in the vertical fuel tank opening, and install the cap screws through the sending unit flange. Connect the sending unit wire to the terminal post of the sending unit. Install the engine compartment front top plate (par. 52 o).

hull. Disconnect priming tube from left fuel shut-off valve. Remove spacer assembly where tubes pass through bulkhead. Work intake priming tube out of hull. Disconnect outlet priming tube from flexible connection under right side of engine, remove tube clip and spacer, and work tube out of hull. Disconnect priming tube from engine beam, and unscrew coupling nut from distributor.

h. Installation of Priming Lines Between Priming Pump and Priming Distributor. Pass the two priming lines into the hull from the crew compartment subfloor opening. Bend the lines in front of the steering brake cross shaft and close to the transmission. Connect coupling nuts to priming pump, making certain that the intake line is attached to the fitting on the priming pump block, and that the outlet line is attached to the fitting on the end of the pump. Tape the lines to the transmission feed line for input shaft (fig. 7). Install the spacer which secures the lines to the bulkhead. Install the clips securing the lines to the hull floor. Connect intake tube to the left fuel shut-off valve. Install the outlet tube spacer on the lower shroud. Connect the outlet tube to the flexible connection under the right side of engine. Install tube on engine support beam, and connect it to priming distributor and to flexible connection under right side of engine. Install propeller shaft (par. 116). Operate priming pump and observe lines for leaks.

67. THROTTLE CONTROLS AND LINKAGE.

a. Description. The throttle controls and linkage consist of a hand throttle, accelerator pedal, and linkage which connects the hand throttle and accelerator pedal to the carburetor. The throttle is connected to the cross shaft by a flexible cable. The accelerator pedal is connected to the cross shaft by linkage. The cross shaft is connected to the carburetor through two accelerator rods and an accelerator shaft lever which is mounted on the bulkhead.

b. Removal of Hand Throttle Control (figs. 49 and 7). Remove driver's seat (par. 140). Remove cap screws from driver's floor rear plate, disconnect hi-idling rods from floor plate lever, and lift out seat support and plate. Loosen jam nuts securing hand throttle to its bracket. Pull out throttle about ½ inch, and remove throttle from bracket. Disconnect rear end of throttle control rod. Loosen jam nuts which secure control rod and cable to floor bracket. Unscrew throttle control rod clevis and jam nut. Pull throttle control assembly from hull.

c. Installation of Hand Throttle Control (figs. 49 and 7). Insert throttle control rod into floor bracket opening from front end. Install rear jam nut, and tighten jam nuts against floor bracket. Install jam nut and control rod clevis on rear end of control rod.

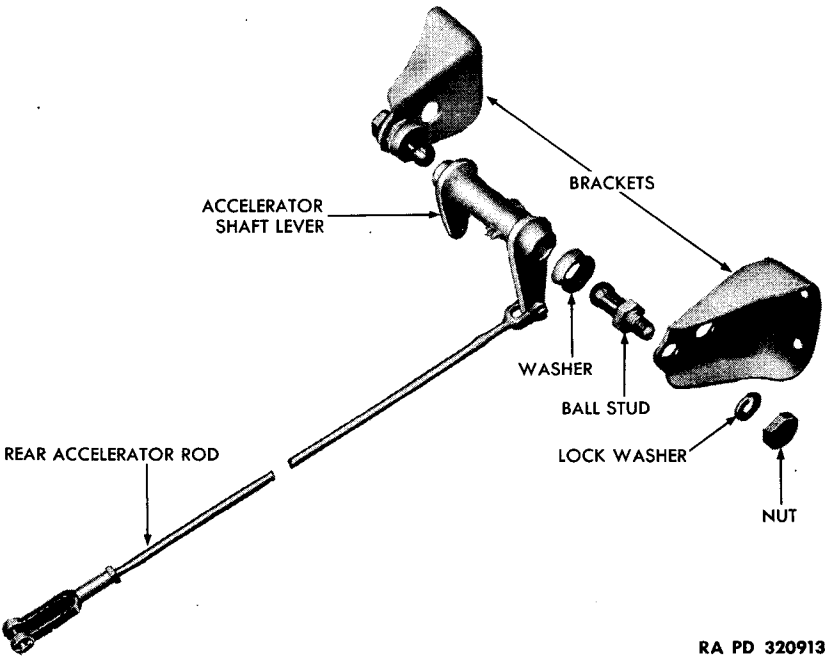


Figure 50 — Accelerator Shaft Lever Assembly

Connect clevis to cross control shaft sleeve lever. Place hand throttle cable in position on bracket, and tighten jam nuts. Install driver's floor rear plate, and connect hi-idling rods to floor plate lever. Install driver's seat (par. 148).

d. Removal of Accelerator Pedal and Linkage (figs. 49 and 7).

(1) REMOVE ACCELERATOR PEDAL AND FRONT LINKAGE. Remove driver's seat (par. 148). Remove driver's floor front plate attaching screws, and lift out floor plate. Remove front accelerator rod. Disconnect accelerator pedal spring from its bracket. Unscrew accelerator pedal bolt, and pull out accelerator pedal and spring from hull. Remove accelerator rod under crew compartment subfloor.

(2) REMOVE ACCELERATOR SHAFT LEVER (figs. 49 and 50). Remove rear subfloor plate in crew compartment. Disconnect rear accelerator rod from accelerator shaft lever on engine side of bulkhead. Remove bolts securing one of the accelerator shaft lever brackets to the bulkhead. Remove ball stud nut and lock washer at the remaining bracket. Remove accelerator shaft lever.

(3) REMOVE REAR ACCELERATOR ROD. Disconnect rear end of the rear accelerator rod, and remove it from the engine compartment.

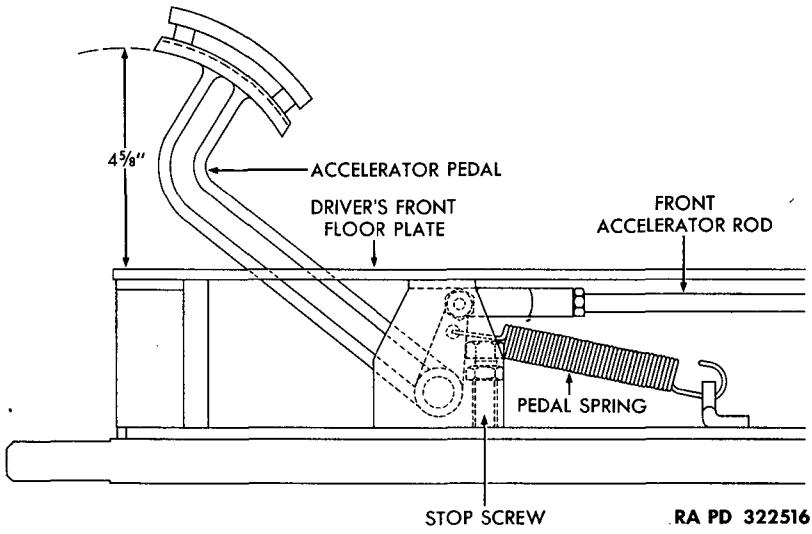


Figure 51 — Accelerator Pedal Adjustment Diagram

c. Installation of Accelerator Pedal and Linkage (fig. 50).

(1) INSTALL REAR ACCELERATOR ROD. Place rear accelerator rod in engine compartment. Connect rear end to carburetor hi-idling linkage.

(2) INSTALL ACCELERATOR SHAFT LEVER (figs. 49 and 50). Install one bracket on bulkhead without the ball stud and washer. Install ball stud, rubber washer, lock washer, and nut on second bracket while bracket is off the bulkhead. Assemble this bracket with the accelerator shaft lever and second rubber washer and ball stud. Hold the assembly together by hand and place it in position. Bolt the bracket to the bulkhead, and attach the lock washer and nut to the ball stud. Connect the rear accelerator rod to the right side of the accelerator shaft lever.

(3) INSTALL ACCELERATOR PEDAL AND LINKAGE (figs. 49 and 7). Place accelerator rod under crew compartment subfloor, and connect rear end to accelerator shaft lever and front end to control cross shaft lever. Place accelerator pedal in position, and install pedal bolt from left side. Connect accelerator pedal spring to pedal and to hull bracket. Place front accelerator rod in position between accelerator pedal and control cross shaft, and install clevis pins and cotter pins. Do not install driver's floor front plate until linkage adjustments are made (step (4) following).

(4) ADJUST ACCELERATOR PEDAL LINKAGE. Adjust pedal stop screw until the pedal foot pad (measured from the front under side)

is 4⅝ inches above the floor plate (fig. 51). Disconnect accelerator rods from cross shaft, and rotate cross shaft sleeve as far as it will go, moving cross shaft lever toward rear. Adjust length of front accelerator rod to fit between accelerator pedal and cross shaft lever, with pedal all the way up. Install accelerator rod. Work pedal up and down, and if it binds, shorten the accelerator rod until action is free.

(5) ADJUST REAR ACCELERATOR ROD. On vehicles so equipped, lengthen or shorten rod to exactly fit between high-low carburetor control and accelerator shaft lever on bulkhead, with clutch pedal properly adjusted in released position, and butterfly valve of carburetor fully closed.

68. IDLE FUEL CUT-OFF AND DEGASSER.

a. Description (fig. 18). The idle fuel cut-off and degasser (G-102-02-02429) is intended to eliminate backfire and to prevent forming of obnoxious gases caused by an overrich fuel mixture that does not burn during deceleration. The degasser is operated by the variation of vacuum in the intake manifold, and by an electric solenoid which is controlled by a push button on the instrument panel.

b. Adjustment. Remove the seal cap and turn adjusting screw clockwise until tight. With engine warmed up, and idle speed and idle mixture adjusted properly, back off the adjusting screw about six or eight notches until the engine surges or rolls. Then accelerate the engine to governed speed (2,400 revolutions per minute) with no-load; suddenly close the throttle; and allow the engine to return to idle. If engine rolls or stops before normal idle is reached, turn adjusting screw in (clockwise) a notch or two and test. Repeat adjustment until the engine resumes idling in a normal manner.

c. Replacement. Unscrew the knurled nut at the end of the flexible conduit and remove terminal from the post. Unscrew the two long screws that hold the cutoff body to the carburetor and remove. To install, place a gasket (G-104-15-93998), on the flange, and attach the degasser to the carburetor with two long screws. Position and tighten terminal in front of the body, and tighten the knurled nut.

69. GOVERNOR (fig. 52).

a. Adjust Governor. Disconnect the linkage from the governor butterfly valve arm on the manifold, brake seal wire, loosen the governor speed adjusting screw lock nut, and set the screw to start a slight tension on the governor spring. Hold the butterfly valve arm against the stop on the manifold to maintain wide-open position, and adjust the linkage to line up the clevis pin hole. Install the clevis pin and cotter pin.

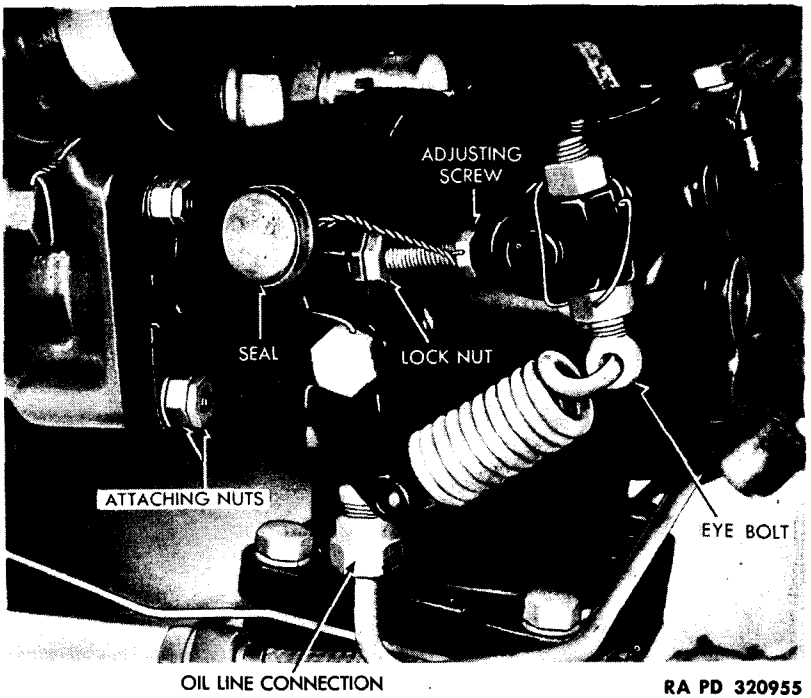


Figure 52 — Governor

b. Check Governor Setting. Start the engine, warm up to operating temperature, and accelerate to top speed. The governor should control the speed of the engine at 2,400 revolutions per minute. If the speed is not properly controlled, screw the governor speed adjusting screw of the governor spring lever in to raise the governed speed, or out to lower the governed speed. Tighten the lock nut when the proper setting is obtained. If speed difference between no load and full load exceeds 150 to 200 revolutions per minute, adjust position of eye bolt to obtain this range. Moving the eye bolt towards the governor oil line will increase the range and help to remedy any surge. Moving the eye bolt away from the oil line will make the governor more sensitive, increase the tendency to surge, and decrease the speed range between no load and full load positions of the throttle. Changing the position of the eye bolt will make it necessary to readjust the governor speed screw.

c. Removal. Disconnect the oil line from the bottom of the governor housing, disconnect the linkage, remove the four attaching nuts which hold the governor on the engine, and remove the governor.

d. Installation. Install the governor on the engine with a new gasket and secure with the four castellated nuts. Lock-wire the mounting nuts. Adjust the governor, connect the linkage as explained in subparagraph a above, and check the setting as explained in subparagraph b above.

Section XVII

ENGINE LUBRICATION SYSTEM

70. DESCRIPTION.

a. The engine lubrication system consists of five major units: the main or pressure and suction pump, scavenger pump, oil filter, oil cooler, and oil supply tank.

b. Oil is drawn from the supply tank through a strainer by the oil pressure pump and forced to the bearings and other moving parts of the engine. An adjustable pressure relief valve built into the pump housing regulates the pressure by allowing the excess oil to pass to the inlet side of the pump. Oil which passes the lubrication points of the engine collects in the engine oil sump and is returned by the suction and scavenger pumps through the oil filter to the supply tank.

c. The thermostatic valve mounted above the oil supply tank allows cold oil to pass directly from filter to the supply tank. As the oil temperature rises, the valve closes and the oil is passed through the oil cooler on the bulkhead before reaching the supply tank.

d. Draining and Filling System.

(1) DRAINING. Remove the hull floor ring plate under the oil supply tank. Remove the engine compartment inspection plate, and remove the lower section of the engine cowling. Remove the drain plug from the engine oil sump, and allow oil to drain from the system.

(2) FILLING. Install the drain plug in the supply tank and the engine oil sump with gasket (G-104-15-93925). Remove the filler cap and fill with the proper grade of oil (par. 21) until oil stands in the filler tube. Insert the bayonet gage and push down into place; this will vent the top of the supply tank and allow the oil in the filler tube to run down into the supply tank. After the engine has been run for a few minutes, shut off engine, remove the filler cap, and add oil until it again rises in the filler tube; then install the filler cap.

71. OIL SUPPLY TANK.

a. Description.

(1) OIL SUPPLY TANK. The oil supply tank is located in the left rear corner of the engine compartment. It consists of a supply

tank and an expansion hopper. Air is expelled from the oil in the expansion hopper before the oil passes to the tank. The tank is filled by means of a filler tube which extends through the engine compartment cover. A bayonet gage attached to the filler cap indicates the amount of oil in the engine lubrication system.

(2) BREATHER. A breather device built into the filler tube is intended to prevent overflowing the tank. When the tank is filled to the proper level, oil will rise in the filler tube. When the bayonet gage is inserted into the tube, the oil in the tube will run down into the tank.

b. Removal.

(1) DRAIN THE OIL SUPPLY TANK (par. 70 d).

(2) REMOVE ENGINE (par. 51).

(3) REMOVE OIL SUPPLY TANK. Disconnect the supply tank inlet oil tube at the top of the tank. Disconnect the oil tube at the rear of the oil filter. Remove breather tube and filler tube from supply tank. Remove the fire extinguisher nozzle bracket from the supply tank. Remove the nuts from the bolts which hold the legs of the oil tank to the hull, and remove the tank.

c. Installation.

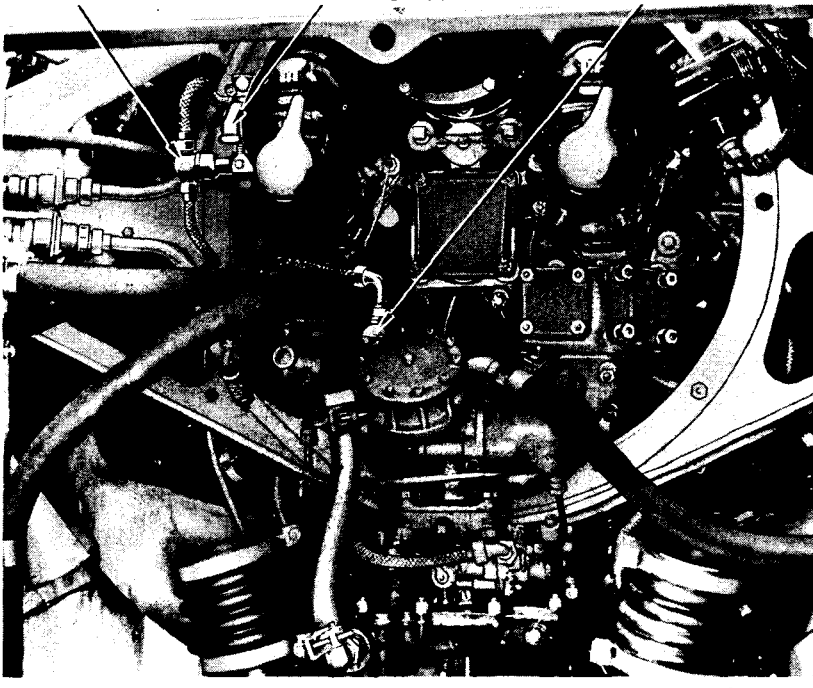
(1) INSTALL OIL SUPPLY TANK. Place the tank in position, and install the attaching nuts. Connect the fire extinguisher nozzle bracket to the oil tank. Install the filler tube on the oil tank, and connect the breather tube. Connect the oil tube to the tank and oil filter.

(2) INSTALL ENGINE. Refer to paragraph 52 for engine installation.

(3) FILL ENGINE LUBRICATING SYSTEM. Refer to paragraph 70 d for oil filling information.

72. PUMP AND GAGE SENDING UNITS.

a. Description. The oil pressure pump and suction pump operate as separate gear pumps but are built into a single pump body mounted on the accessory case at the rear of the engine. An oil strainer is built into the inlet side of the pressure pump, and the oil pressure relief valve is built into the pressure side of the pump. The oil temperature sending unit (CWR-203142), is attached to the oil pump at the oil strainer. The oil pressure sending unit (KS-40374), and the low oil pressure switch (G-148-04-19385), are mounted to the same fitting at the left side of the accessory case (fig. 53). The oil pressure sending unit is the larger of the two units and is mounted in a vertical position. The low pressure unit is mounted in a horizontal position.



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Figure 53 — Oil Gage Sending Units

b. Removal of Oil Pressure and Suction Pump (fig. 56). Disconnect the oil temperature gage sending unit cable. Disconnect the inlet and outlet hose from the pump, and raise the ends of the hose above the oil level in the supply tank. Disconnect the governor linkage at the carburetor, and disconnect the oil drain tube from the governor. Remove lock wire and cotter pins from the pump attaching nuts and remove nuts, using wrench (41-W-1577-500), to remove the nuts from the right side. Pull out the unit, and remove the governor from the pump. Keep the accessory case opening covered while the pump is off.

c. Installation of Oil Pressure and Suction Pump (fig. 56). Attach the governor to the pump. Place the pump (G-104-29-94152), in a position with gasket (CWR-202-194), and install the attaching nuts and washers (G-104-01-03310), using special wrench (41-W-1577-500). Install cotter pins through the attaching nuts on the right side of the pump and a lock wire through the nuts on

ENGINE LUBRICATION SYSTEM

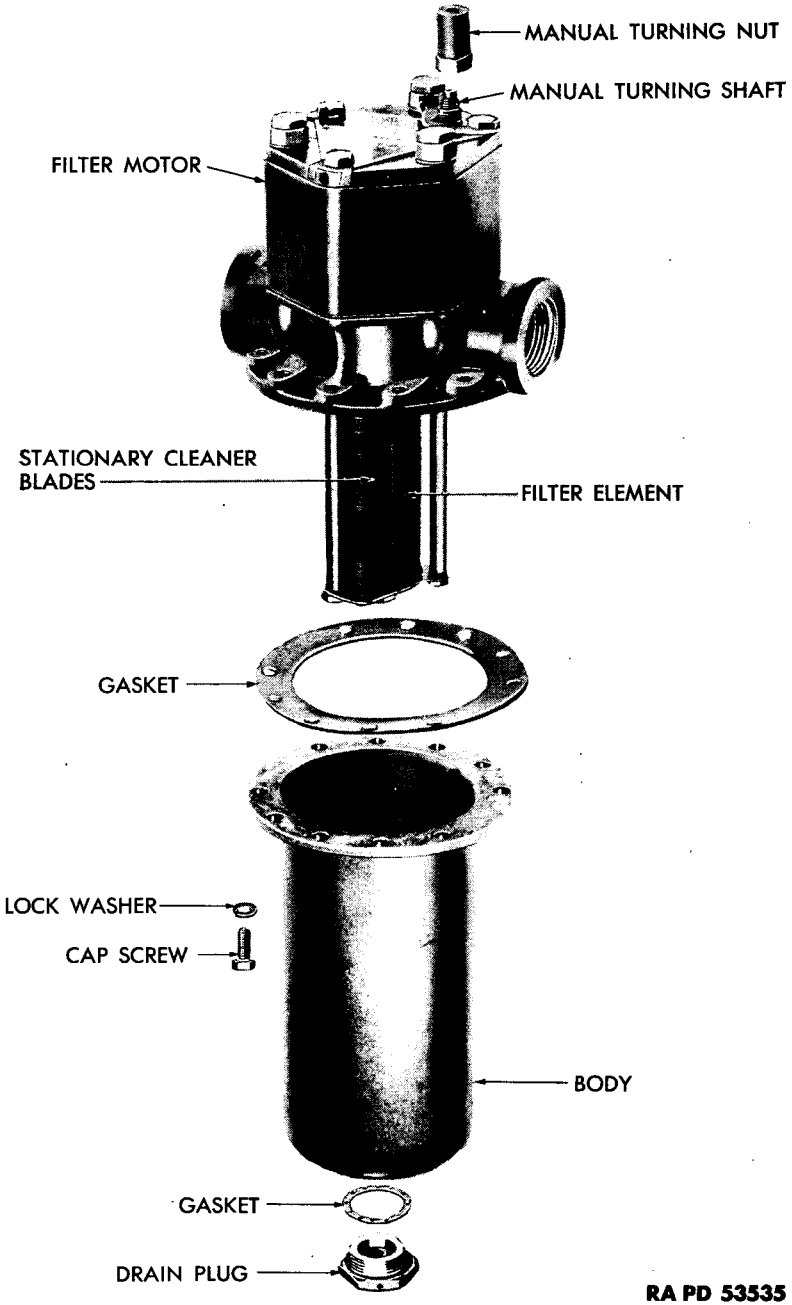


Figure 54 — Oil Filter Disassembled

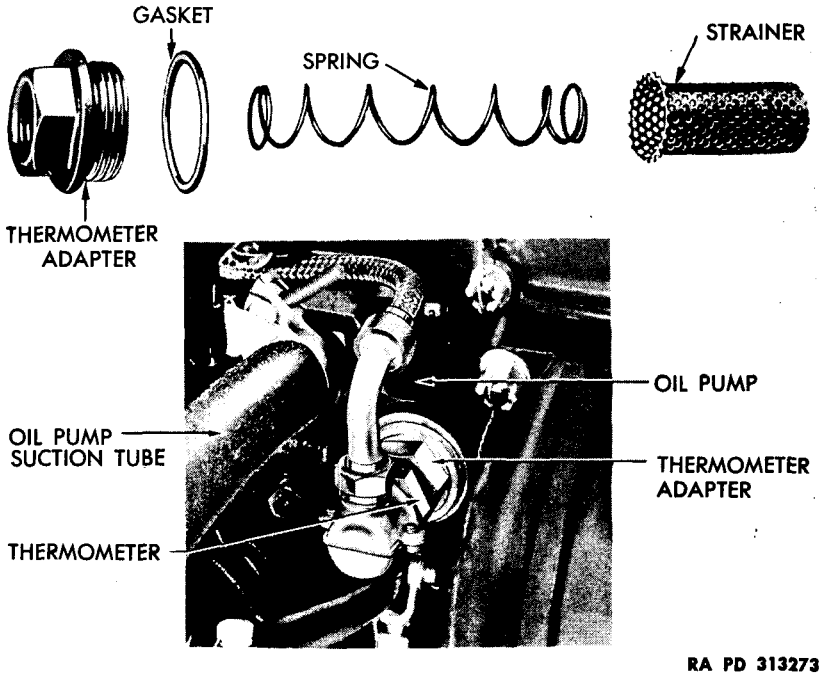


Figure 55 — Oil Suction Strainer

the left side. Connect the governor linkage to the carburetor and the oil drain tube to the governor. Connect the oil inlet and outlet tubes to the pump. Connect the oil temperature gage sending unit cable to the oil strainer.

d. Replacement of Gage Sending Units. Remove the cover, disconnect the wire, and unscrew the unit from the fitting. To install, screw the unit into place, connect the wire, and install the cover.

73. OIL FILTER.

a. Description (fig. 54). The oil filter is a revolving disk-type filter, mounted above the oil supply tank in the left rear corner of the engine compartment. The filter disks are rotated by oil pressure from the accessory case.

b. Removal. Unscrew the inlet tube on one side and outlet tube on the other side of the oil filter. Disconnect the oil filter to accessory case hose at the filter. Remove the bolts from the bracket that holds the filter body, and lift out the filter. Remove the lock wire on the cap screws, and remove cap screws and washers. Lift the filter head and gasket from the filter body. Remove the lock wire, gasket, and drain plug from the bottom of the filter.

c. Maintenance. Thoroughly clean the filter element in dry-cleaning solvent. Do not disassemble the disk assembly.

d. Installation. Place a new filter body gasket in position, and lower the filter into the body. Position the cap screws, tighten, and lock-wire together. Screw the drain plug in place and lock with wire. Place filter in the bracket, install bolt in bracket, and tighten. Connect scavenger pump tube to the side of the cover marked "IN," otherwise the filter will not function. Connect and tighten filter outlet line to the oil temperature control and the oil filter to accessory case hose at the filter.

74. OIL SUCTION STRAINER.

a. Description (fig. 55). The oil suction strainer, which is mounted in the inlet side of the oil pressure pump at the right of the governor, strains the oil before it enters the pump.

b. Removal. Disconnect the wire from the oil temperature gage sending unit. Remove the sending unit and adapter. Remove the strainer and spring.

c. Installation. Clean the strainer and spring thoroughly, and insert them into the pump body. Place a good gasket over the sending unit adapter, and install the adapter and temperature sending unit.

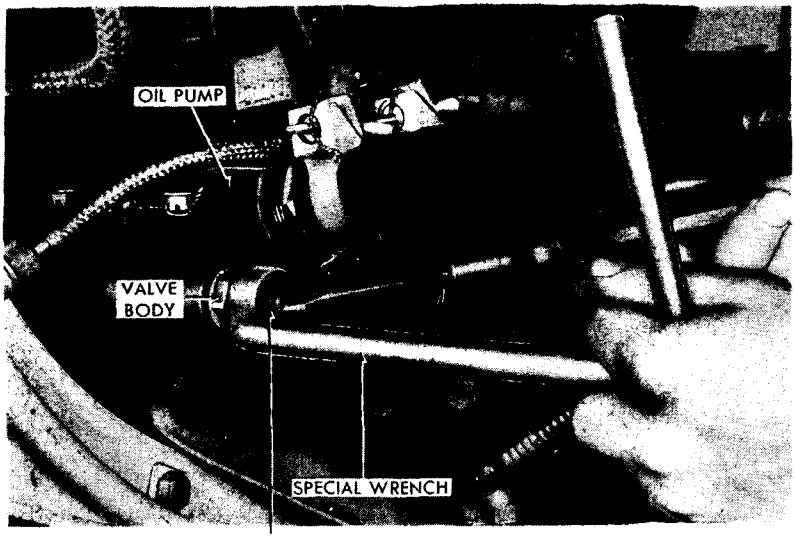
75. ENGINE OIL COOLER AND BY-PASS VALVE.

a. Description (fig. 58). The engine oil cooler is mounted on the crew compartment side of the bulkhead to the left of the propeller shaft. Circulation of oil through the oil cooler is controlled by a thermostat by-pass valve mounted in the engine compartment above the oil supply tank. When the oil is cold, the valve shuts off the circulation of oil to the oil cooler, and allows the oil to pass directly from the filter to the supply tank. As the oil temperature raises, the valve causes the oil to pass through the oil cooler before reaching the supply tank.

b. Engine Oil Cooler Maintenance. Oil coolers must be removed and thoroughly cleaned. Clean out interior oil passages with steam, or flush with dry-cleaning solvent. Blow out fins and air passages with compressed air.

c. Removal of Oil Cooler. Remove the section of the subfloor in front of the oil cooler. Disconnect the oil inlet and outlet tubes. Remove the cap screws which hold the cooler guard to the bulkhead, and remove the guard. Remove the cooler attaching cap screws, and lift out the cooler.

d. Installation of Oil Cooler. Place the cooler in position, and install the mounting cap screws. Install the cooler guard. Connect



OIL PRESSURE RELIEF VALVE ADJUSTING SCREW RA PD 320954

Figure 56 — Adjusting Oil Pressure, Using Special Pressure Relief Valve Wrench (41-W-636-620)

the oil inlet and outlet tubes, and install the section of the subfloor. Check the oil level in the supply tank, and add the amount of oil which was lost when the cooler was removed.

e. Removal of By-pass Valve. Disconnect the oil tubes from the valve. Remove the attaching cap screws, and lift off the valve.

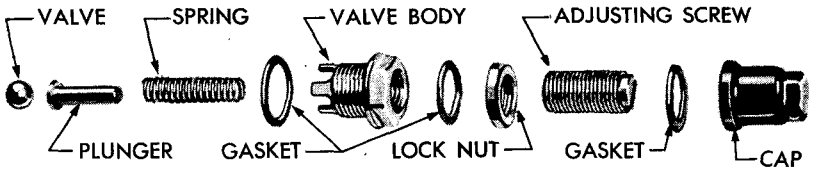
f. Installation of By-pass Valve. Place the valve in position on fuel tank shield, and install attaching cap screws. Connect the oil tube from the top of the oil supply tank to the upper rear connection, the oil tube from the filter to the lower rear connection, and the two tubes from the oil cooler to the front connections.

76. OIL DILUTION VALVE AND SOLENOID.

a. Description. On early model vehicles, an oil dilution valve permits engine oil to be thinned with gasoline in cold weather. The valve is solenoid-operated and is located on the left side of the engine support beam. When open, the valve allows gasoline to flow through a line from the carburetor into the main oil inlet line, thus diluting the oil. The solenoid is operated by a toggle switch on the instrument panel (par. 12 f).

77. OIL PRESSURE RELIEF VALVE.

a. Description. The oil pressure relief valve is built into the pressure side of the oil pump body.



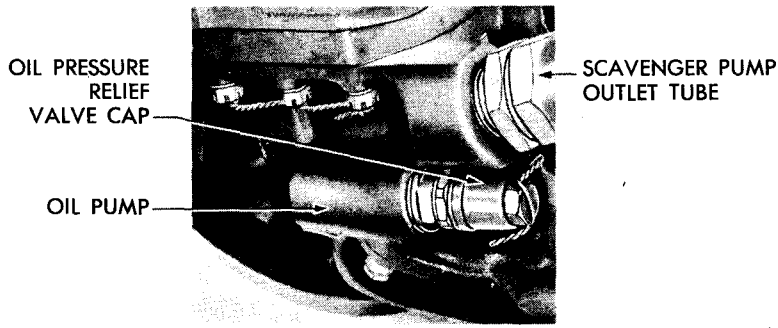


Figure 57 — Oil Pressure Relief Valve

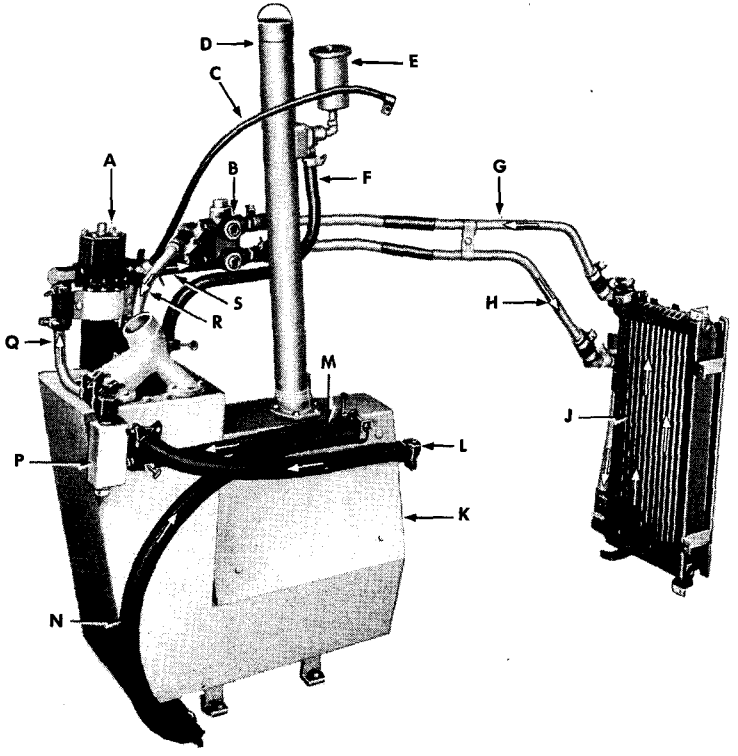
b. Adjustment of Pressure Relief Valve (fig. 56). Remove the oil pressure relief valve cap, and using special wrench (41-W-636-620), loosen the adjusting screw lock nut. Hold the adjusting screw lock nut with special wrench, and turn the adjusting screw clockwise to raise pressure, or counterclockwise to reduce the pressure. Normal pressure at operating speeds is 50 to 90 pounds. Desired pressure is 70 pounds plus or minus 5 pounds. Tighten lock nut, install the cap and lock wire after making adjustment.

c. Replacement of Oil Pressure Relief Valve (fig. 57). Remove the lock wire from the cap, and screw the relief valve assembly from the oil pump body, using special wrench (41-W-636-620). Place a new gasket over the relief valve body, and screw the assembly into the pump body. Check the engine oil pressure and adjust if necessary (subpar. b above). If no adjustment is required, install the cap and lock wire.

78. OIL LINES AND CONNECTIONS (fig. 58).

a. Description. The oil lines consist of a supply and return line between the by-pass valve and the engine oil cooler, a line between the filler pipe breather and the top of the supply tank, a by-pass line connecting the by-pass valve with the top of the supply tank, a supply line connecting the by-pass valve and oil filter, a line connecting the oil filter and distribution block on the side of the oil tank, an oil pressure line connecting the oil filter and the left side of the

A—OIL FILTER
B—BY-PASS VALVE
C—OIL PRESSURE TUBE
D—FILLER PIPE
E—BREATHER
F—BREATHER TUBE
G—OIL COOLER INLET TUBE
H—OIL COOLER OUTLET TUBE
J—ENGINE OIL COOLER
K—OIL SUPPLY TANK
L—MAIN SCAVENGER OUTLET TUBE
M—FRONT SCAVENGER OUTLET TUBE
N—OIL PUMP INLET TUBE
P—DISTRIBUTION BLOCK
Q—DISTRIBUTION BLOCK TO OIL FILTER TUBE
R—BY-PASS VALVE TO SUPPLY TANK TUBE
S—OIL FILTER TO BY-PASS VALVE TUBE



RA PD 320957

Figure 58 — Engine Lubricating System Oil Lines and Connections

accessory case, a front scavenger outlet tube connecting the front scavenger pump with the distribution block, a main scavenger outlet tube connecting the oil pump outlet with the distribution block, and an oil pump inlet tube connecting the supply tank and the oil pump inlet. The lines are either flexible hose or a combination of metal tube with a section of flexible hose at each end to reduce vibration.

b. Removal.

(1) REMOVE SUPPLY AND RETURN LINES BETWEEN BY-PASS VALVE AND ENGINE OIL COOLER. Remove engine (par. 51). Remove clip securing lines to fuel tank shield. Loosen hose clamps, and disconnect lines for oil cooler and by-pass valve. Remove left lower engine shroud and shroud seal attaching screws. Remove shroud and oil lines.

(2) REMOVE OTHER OIL LINES. Loosen hose clamps and pull lines from connection at each end.

c. Installation.

(1) INSTALL SUPPLY AND RETURN LINES BETWEEN BY-PASS VALVE AND ENGINE OIL COOLER. Assemble oil lines and position them in engine compartment. Connect hose at front end to engine oil cooler and at rear end to by-pass valve. Tighten clamps. Secure lines to fuel tank shield with clip, cap screw, and toothed lock washer. See that toothed lock washer makes good bond (par. 164 **b** (4)). Install engine lower shroud, seal, and secure with cap screws. Install engine (par. 52).

(2) INSTALL OTHER OIL LINES. Place oil line in position, and fit each end over its connection. Tighten clamps.

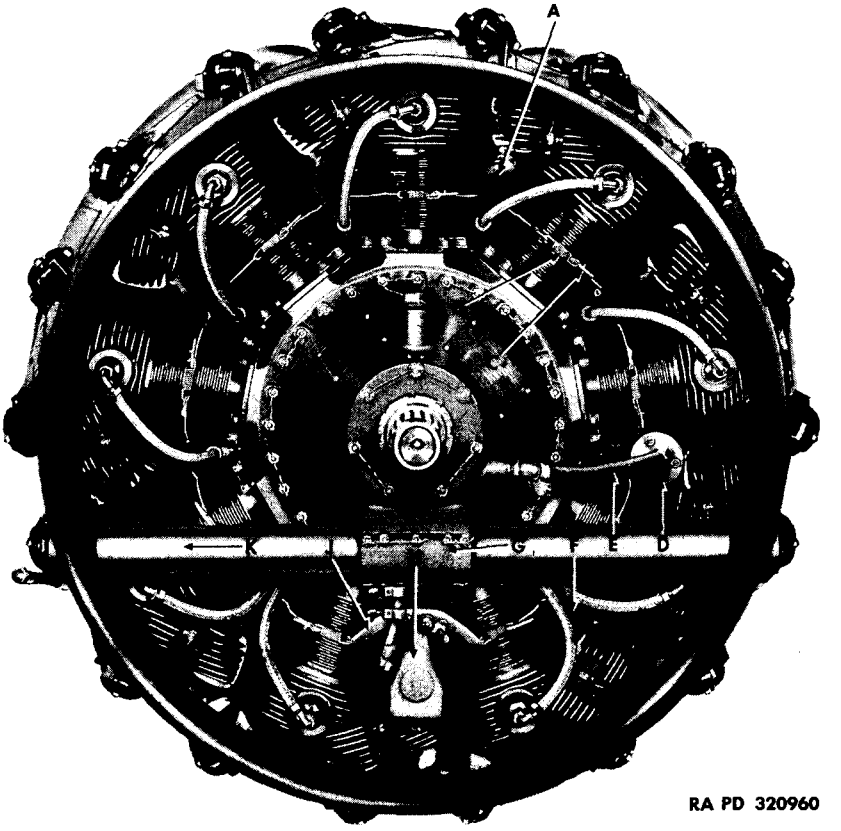
Section XVIII

COOLING SYSTEM

79. DESCRIPTION (fig. 59).

a. The engine fan, mounted on the flywheel, draws cooling air through the air intake shutter, and expels air through the engine cowl to the rear of the engine compartment, where it is discharged into the atmosphere through the outlet shutter. As the air passes through the cowl, it is directed against the finned surfaces of the engine cylinders by a system of cylinder head and intercylinder baffles installed close to the cylinder barrels, which assist in keeping the cylinders cool.

CARRIAGE, MOTOR, 105-MM HOWITZER, M7



RA PD 320960

A—SINGLE IGNITION WIRE AIR DEFLECTOR (BETWEEN NOS. 1-2, 2-3, 3-4, 8-9, 9-1 CYLINDERS)
B—HINGED CLAMP SPRING
C—HINGED CLAMP
D—WASHER
E—FRONT SCAVENGER OUTLET TUBE
F—DOUBLE IGNITION WIRE AIR DEFLECTOR (BETWEEN NOS. 4-5, AND 6-7 CYLINDERS)
G—ENGINE SUPPORT CAP
H—OIL SUMP
J—CONNECTING FRONT BRACE
K—ENGINE SUPPORT TUBE

Figure 59 — Cylinder Air Deflectors — Front View

80. MAINTENANCE.

a. Remove dust and oil or foreign matter which may have lodged between the cylinder fins or inside the cylinder air deflectors, otherwise the engine may become overheated. To clean the cooling system without removing the deflectors, remove the engine (par. 51) and remove the engine fan (par. 109 a). Using a pressure tank, direct a stream of cleaning solvent against the engine cylinders and between the cylinders and air deflectors. When the metal is thoroughly clean, dry the engine with an air pressure line. Remove

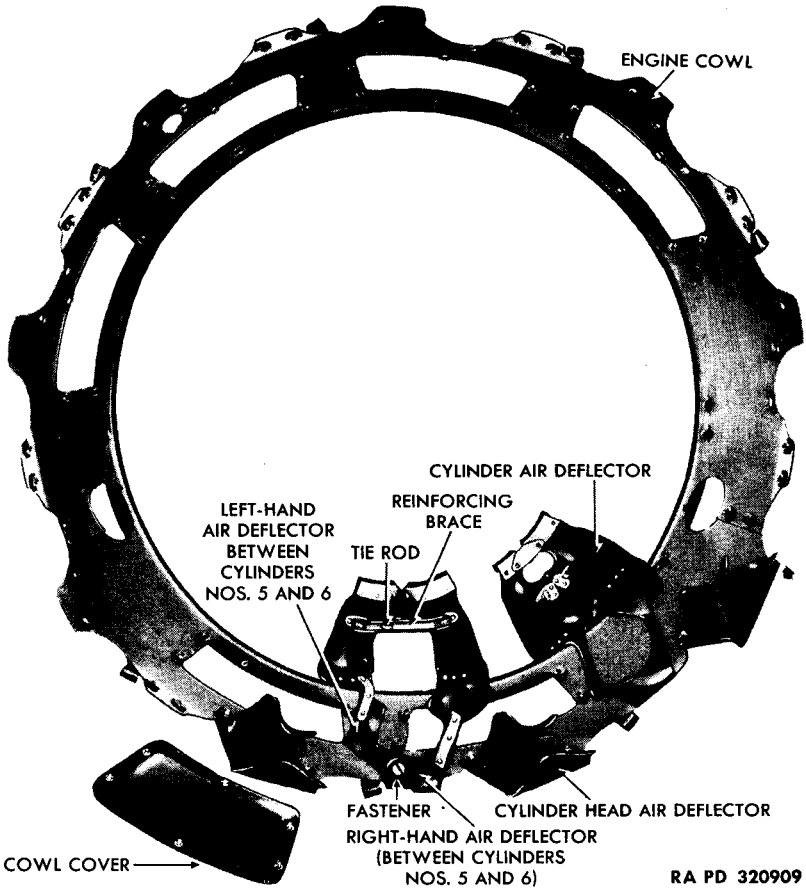


Figure 60 — Engine Cowl and Air Deflection

cylinder air deflectors which appear to be bent or dented, and hammer out dents or install new deflector. Replace spring clamps if any are found to be loose. Install engine fan (par. 109 b). Install engine (par. 52).

81. COWL (fig. 60).

a. Description. The engine cowl is made in three sections: the upper and lower sections, and the outer ring. After assembly at the factory, the upper and lower sections are sometimes spot-welded along the joint. However, for removal purposes, the cowl can be left in one piece. There are six removable covers in the cowl for

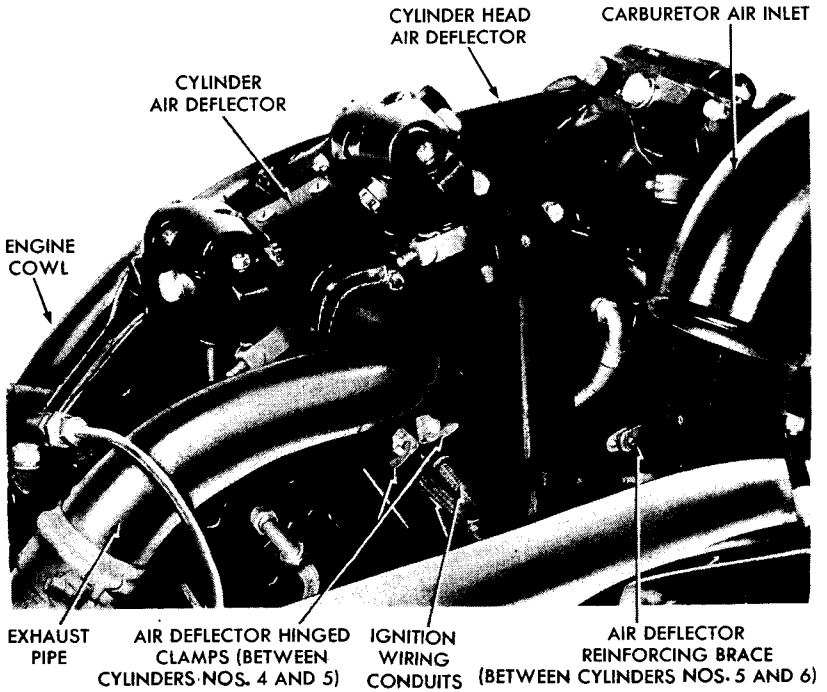


Figure 61 — Cylinder Head and Intercylinder Air Deflectors Installed

inspecting or servicing parts of the engine through the openings. The cowl is attached to the cowl mounting bosses at the front of the engine rocker boxes.

b. Removal. Remove the engine (par. 51). Remove the clutch, flywheel, and fan (par. 109 a). Disengage the bayonet-type fasteners which secure the intercylinder and cylinder head air deflectors to the cowl. The fasteners are disengaged by turning them one-fourth turn in a counterclockwise direction. Remove the cotter pins, nuts, spacers, lock washers, and bolts which secure the cowl to the bosses on the front of the rocker boxes. Turn the engine mounting plate until the engine is in a horizontal position, with the front end up, and lock the engine in this position. Remove engine support cap and tube. Lift off the cowl in one piece.

c. Installation. Place the cowl in position on the engine. Insert the engine support tube through the holes in cowl. Install the engine support cap (par. 52). Attach the cowl to the bosses on the front of the rocker boxes, using bolts, spacers, lock washers, nuts, and cotter pins. Attach the intercylinder and cylinder head air deflectors to

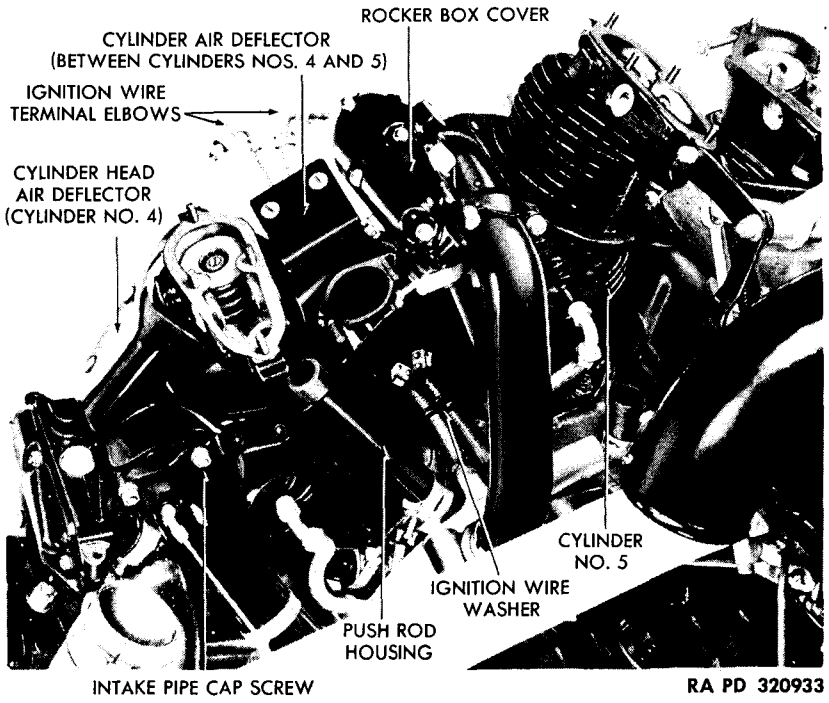


Figure 62 — Removing Intercylinder Air Deflectors

the cowl by turning the bayonet-type fasteners one-fourth turn. Install the fan, flywheel, and clutch (par. 109 b).

82. AIR DEFLECTORS.

a. Description (fig. 61). The air deflectors are of two types, the intercylinder air deflector, and cylinder head air deflector. Eight of the intercylinder air deflectors are of one-piece construction and are attached to the cylinder heads by means of hinged clamps and springs which fasten together around the front of each cylinder barrel. Two bayonet-type fasteners attach the outer end of each deflector to the cowl. The intercylinder air deflector between cylinders Nos. 5 and 6 is of two-piece construction. It is secured to a brace on the oil sump by a tie rod, and is also attached to the cowl. The cylinder head air deflectors are attached to one of the intake pipe cap screws, and are also secured to the cowl by means of bayonet-type fasteners.

b. Removal of Cylinder Head Air Deflectors. Remove two bayonet-type fasteners which secure each deflector to cowl, and remove intake pipe cap screw which secures each deflector. Lift off deflector from engine.

c. Removal of Cylinder Air Deflectors (Except Between Cylinders Nos. 5 and 6).

(1) REMOVE ENGINE. Refer to paragraph 51 for engine removal.

(2) REMOVE CLUTCH, FLYWHEEL, AND FAN. Refer to paragraph 109 a for removal procedure.

(3) RELEASE BAYONET-TYPE FASTENEPS (fig. 62). Turn bayonet-type fasteners one-quarter turn and release deflector from cowl.

(4) REMOVE EXHAUST PIPE. Loosen clamps at ends of exhaust pipe, and remove exhaust port flange bolts from segment of exhaust pipe which is adjacent to air deflector being removed. Remove exhaust pipe segment and gasket.

(5) DISCONNECT IGNITION WIRES. Disconnect ignition wire terminal elbow from spark plug on conduits which pass through air deflector. Pull terminals out of spark plugs. Remove bolts which secure ignition wire washer assembly to air deflector. Pull ignition wire conduits and washer out of deflector. NOTE: *If removing deflector between cylinders Nos. 7 and 8, remove front scavenger outlet tube from engine instead of ignition wire.* Remove washer attaching bolts and pull tube out of deflector.

(6) DISENGAGE THE AIR DEFLECTOR HINGED CLAMPS. Remove cotter pin, and open the hinged clamps which secure the air deflector to the adjacent cylinders. Unhook these clamps from the deflector.

(7) REMOVE PUSH ROD HOUSING. Refer to paragraph 49 for removal of push rod housing.

(8) LIFT OUT AIR DEFLECTOR FROM CYLINDER. Remove deflector.

d. Removal of Cylinder Air Deflector Between Cylinders Nos. 5 and 6.

(1) REMOVE ENGINE. Refer to paragraph 51 for engine removal.

(2) REMOVE CLUTCH, FLYWHEEL, AND FAN. Refer to paragraph 109 a for removal procedure.

(3) REMOVE AIR DEFLECTOR (fig. 61). Release the hinged clamps and remove clamp springs from connecting front brace which is attached to engine sump. Release the two tie rods which connect the front brace and the reinforcing brace by forcing the end of the tie rod out of its seat. Remove push rod housings from No. 5 cylinder exhaust and No. 6 cylinder intake. Remove safety wire and two cap screws which attach the reinforcing brace to the right and left halves of the air deflector. Release the bayonet-type fastener which joins the two halves of the air deflector. Remove two halves of air deflector. Remove the tie rod and reinforcing brace.

e. Installation of Cylinder Air Deflector Between Cylinders Nos. 5 and 6 (fig. 61). Place left- and right-hand air deflector in

position between cylinders Nos. 5 and 6. Lock the two halves together by turning the bayonet-type fastener at the bottom of the deflectors. Place the tie rod and reinforcing brace in position between the two halves. Install reinforcing brace cap screws and lockwire. Engage the tie rod with the connecting front brace. Lock the fasteners which attach the reinforcing brace to the cowl. Engage the hinged clamp springs with each end of the connecting front brace, and lock the hinged clamps. Install push rod housings (par. 49). Install rocker box arms (par. 48). Install clutch, flywheel, and fan (par. 109 b). Install engine (par. 52).

f. Installation of Cylinder Air Deflectors (Except Between Cylinders Nos. 5 and 6 (fig. 62)). Insert ignition wires (or tube) with washer in opening in air deflector, making sure the air deflector has one opening suitable for one ignition wire if used between cylinders Nos. 1-2, 2-3, 3-4, 8-9, or 9-1; or two openings for two wires if used between cylinders Nos. 4-5, or 6-7; or large single opening for front scavenger outlet tube if used between cylinders Nos. 7-8. Install ignition wire terminals on spark plugs (par. 59 c) or front scavenger outlet tube on engine nipple. Install conduit or tube washer attaching bolts. Place hinged clamp halves in position on each side of deflector and lock the clamps with cotter pins. Install push rod housings (par. 49). Install rocker box arms (par. 48). Install exhaust pipe segment. Attach deflector to engine cowl with bayonet-type fasteners. Install clutch, flywheel, and fan (par. 109 b). Install engine (par. 52).

g. Installation of Cylinder Head Air Deflector. Place deflector in position. Install intake pipe cap screw and lock nut through deflector opening. Engage and tighten bayonet-type fasteners which secure deflector to cowl.

Section XIX

STARTING SYSTEM

83. DESCRIPTION AND DATA.

a. Description. The starting system consists of a 24-volt cranking motor (D47397A) equipped with a hand crank attachment mounted on the engine accessory case. The motor is connected, through the bulkhead terminal box, to a solenoid switch by a cable marked "16." The solenoid is connected to the 24-volt bus bar by a cable marked "17," and the actuating circuit of the solenoid is connected to the switch marked "STARTER" on the instrument panel by a wire marked "18." When the "STARTER" switch is operated, the actuating circuit of the solenoid switch is energized, which closes

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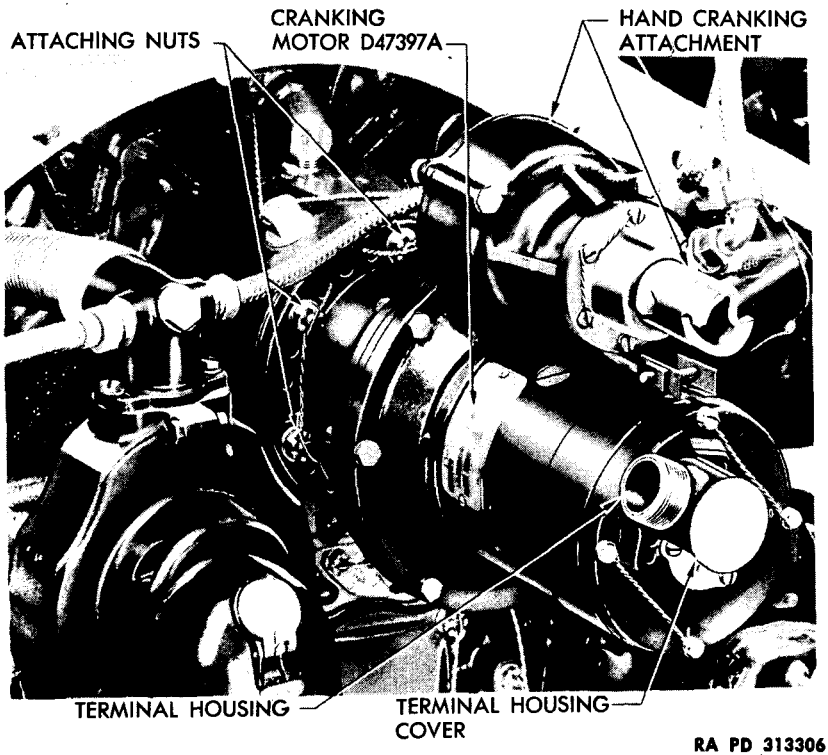


Figure 63 — Cranking Motor

the heavy current circuit through the cables to the cranking motor. The solenoid switch eliminates the necessity of running the heavy cables to the front of the vehicle and the use of a large capacity switch for completing the circuit.

b. Data.

(1) CRANKING MOTOR.

Manufacturer ..... Delco-Remy Div. General Motors Corp.
Model EC-817

(2) SOLENOID SWITCH.

Manufacturer ..... Electric Auto-Lite Corp.
Ordnance drawing number B-183391

84. CRANKING MOTOR.

a. Removal. Open the master switch. Open the rear doors and remove the cover plug from the cranking motor cable terminal housing. Unscrew the conduit coupling nut. Disconnect the cable from

the terminal, and pull the cable out of the terminal housing. Remove the lock wire and mounting nuts from the cranking motor flange studs, using special wrench (41-W-871-45) (fig. 29) to remove inaccessible mounting nuts, and remove the assembly.

b. Installation. Position the cranking motor on the attaching studs with the hand crank attachment up. Install the nuts and lockwire. Connect the cable to the terminal, attach the conduit, and tighten the coupling ring. Install the conduit clamp to the hull wall, screw the terminal housing cover plug in place, and lock-wire. Turn on the master battery switch. Place the gearshift in neutral, and press the switch on the instrument panel marked "STARTER" to test the operation of the cranking motor. Then turn off the battery master switch and close the rear doors.

85. SOLENOID SWITCH.

a. Removal. Turn off master switch. Remove the cover from the bulkhead terminal box, and disconnect the wires and cables from the solenoid switch terminals. Note the identifying numbers on the cables and wires so that proper connections can be made when installing the switch. Remove the attaching screws which hold the switch bracket to the terminal box, and remove the solenoid switch.

b. Installation. Position the solenoid switch into the terminal box, and install the attaching screws. Connect the cables and wires as identified when removed, and make sure that the solenoid switch ground wire is secure. See that the gearshift lever is in neutral, and warn any personnel that may be working in engine compartment. Turn on the master battery switch and press the "STARTER" switch to test the operation of the solenoid switch. Turn off the battery master switch, and install the switch box cover.

86. WIRING.

a. Description (fig. 64). The wiring for the starting system consists of wires and cables which connect the instrument panel starting switch, cranking motor solenoid switch, 24-volt bus bar in the bulkhead terminal box, the cranking motor on the rear of the engine, and the solenoid switch to ground.

b. Replacement.

(1) INSTRUMENT PANEL STARTING SWITCH TO SOLENOID SWITCH WIRE NO. 18. Turn off the master switch. Remove the lower left instrument panel wiring harness from the instrument panel (par. 97 **b** (7)). Disconnect wire No. 18 from instrument panel terminal box. Remove cover from bulkhead terminal box, and disconnect wire No. 18 from solenoid switch terminal. Attach new wire to end of old wire, and pull new wire through conduit. Install terminals on wire,

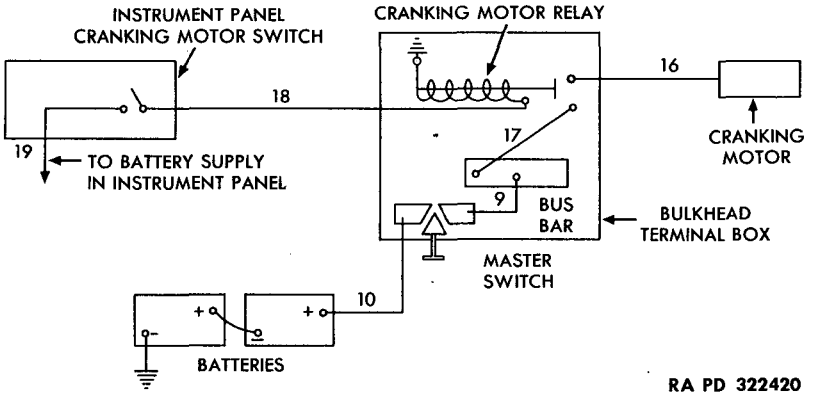


Figure 64 — Starting System Wiring Diagram (Late Models)

and connect terminals of new wire to solenoid switch and part of instrument panel terminal box. Install new instrument panel wiring harness. Install cover on bulkhead terminal box.

(2) SOLENOID SWITCH TO BUS BAR CABLE NO. 17. Turn off master switch. Remove cover from bulkhead terminal box. Remove cable No. 17 from solenoid switch and bus bar. Install new cable between terminals of solenoid switch and lowest terminal of bus bar. Install terminal box cover.

(3) SOLENOID SWITCH TO CRANKING MOTOR CABLE NO. 16. Open master switch. Remove bulkhead terminal box cover. Remove cable No. 16 from solenoid switch. Open rear engine compartment doors. Disconnect cable from cranking motor. Attach new cable to end of old cable, and pull new cable into conduit. Connect ends of cable to cranking motor terminal and solenoid switch. Install cover on bulkhead terminal box.

Section XX

GENERATING SYSTEM

87. DESCRIPTION.

a. The generating system consists of a generator driven from the propeller shaft to maintain a charge in the two 12-volt batteries. The output of the generator is controlled by a generator regulator, and the current flow is indicated by an ammeter installed in the instrument panel. A 60-ampere circuit breaker mounted in the bulkhead terminal box is wired into the line between the regulator and the shunt to protect the system against a short circuit (fig. 65). The reset button protrudes through the bottom of the terminal box.

GENERATING SYSTEM

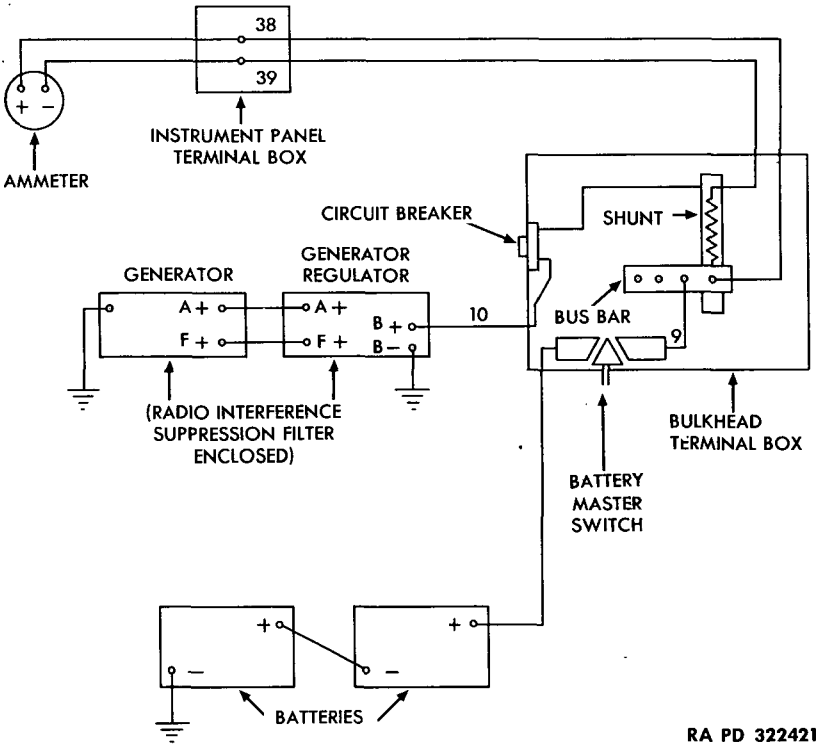


Figure 65 — Generating System Wiring Diagram (Late Models)

88. GENERATOR.

a. Description and Data.

(1) DESCRIPTION (fig. 66). The generator is a shunt-wound, 50-ampere unit mounted in a cradle on the subfloor to the left and rear of the transmission. It is driven by two belts from a pulley attached to the front universal joint flange of the propeller shaft. The belts are adjustable by means of the adjusting arm and cradle which holds the generator in the generator bracket.

(2) DATA.

Manufacturer ..... Electric Auto-Lite Corp.
Ordnance drawing number D-52488-D

b. Removal.

(1) DISCONNECT WIRES. Open the master switch. Remove the terminal cover from the rear of the generator, disconnect the two wires, and remove the wiring harness from the terminal box by un-

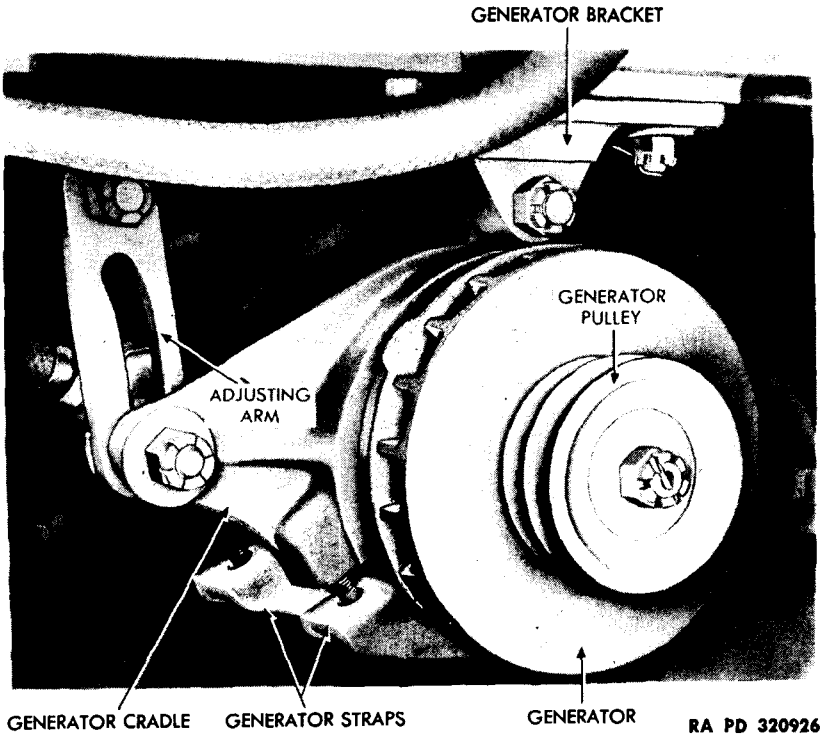


Figure 66 — Generator Assembly

screwing the harness connector. Disconnect ground wire from generator (fig. 67).

(2) REMOVE GENERATOR. Remove the drive belt guard. Loosen the adjusting arm bolts, and rotate the generator toward the propeller shaft. Remove the drive belts from the generator pulley. Remove the generator strap bolts, and lower the generator out of the cradle.

c. Installation.

(1) MOUNT GENERATOR IN CRADLE. Place generator in the generator cradle, and place generator straps in position. Install strap bolts. Place the two drive belts on the generator pulley and the propeller shaft pulley.

(2) ADJUST DRIVE BELTS. Swing the generator down to tighten the belts. Adjust belt tension so there is ½-inch deflection in the belts, with an 8- to 10-pound pull, measured midway between the pulleys. Hold the generator in this position, and tighten the adjusting nuts. Install the drive belt guard.

(3) CONNECT WIRES. Insert the two wires from the generator to regulator conduit through the connector in the rear end of the

GENERATING SYSTEM

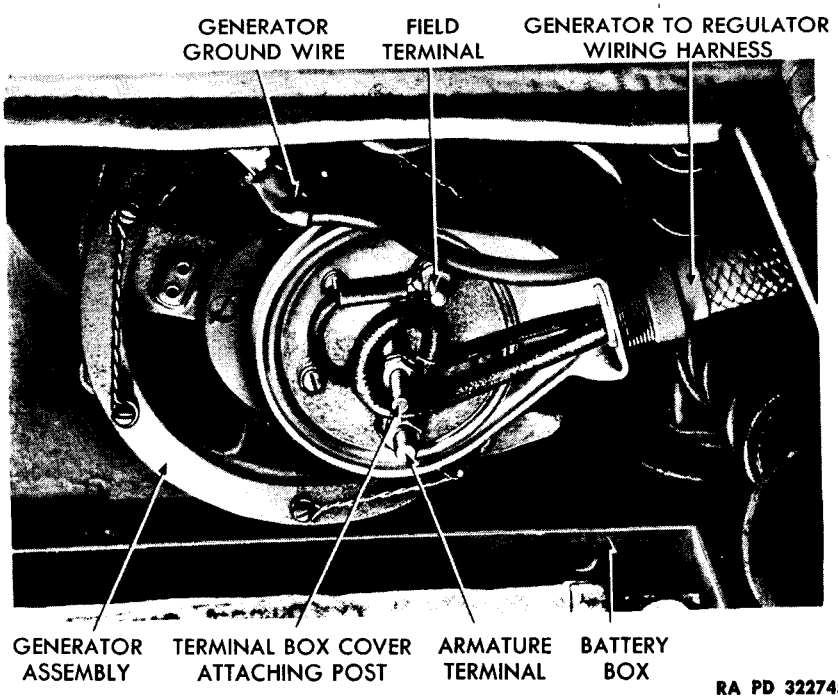


Figure 67 — Generator Wiring Terminals

generator, and attach each wire to the proper terminal. Place the generator terminal cover in position on the attaching part, install the wing nut, and lock-wire. Attach the ground wire on the rear of the generator with a toothed lock washer and cap screw.

89. GENERATOR REGULATOR.

a. Description and Data.

(1) DESCRIPTION (fig. 68). One 3-unit regulator is used in the generating circuit for controlling the output of the generator. The regulator contains a reverse current circuit breaker to disconnect the battery circuit when the generator is not charging, a current limit relay, a voltage control, and a radio filter and capacitor. The regulator is shock-mounted on a bracket at the rear of the transmission.

(2) DATA.

Manufacturer ..... Electric Auto-Lite Corp.
Model 7000061

b. Removal. Open the battery master switch, and remove the terminal box cover. Disconnect the three leads in the terminal box, unscrew the conduit connectors, and pull out the wires. Remove the

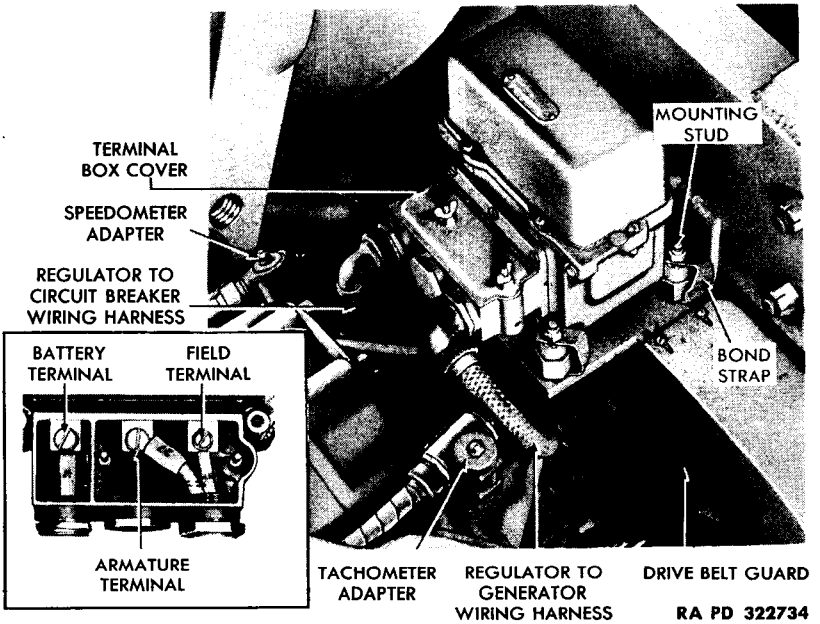


Figure 68 — Generator Regulator Installed

four safety nuts which hold the regulator to the shock mounts, and lift off the regulator.

c. Installation. If the regulator to be installed does not have elbows in the terminal box, install one elbow fitted with a lock nut in the end hole of the large compartment and another in the other end hole. Install a plug in the remaining hole. Set the regulator on the rubber shock mounts on the bracket over the propeller shaft. Install the attaching nuts. Insert the wire (No. 25) from the single wire conduit into the elbow leading into the small compartment of the terminal box, and attach the wire to the terminal marked "BATT." Attach the conduit to the elbow. Insert the two wires from the remaining conduit through the remaining elbow, and connect the large wire (No. 27) to the terminal marked "ARM," with a toothed lock washer between the wire terminal and the regulator terminal and a plain lock washer under the head of the terminal screw. Connect the small wire (No. 26) to the terminal marked "FIELD." Attach the conduit to the elbow, install the terminal cover, and lock-wire the wing nuts.

90. WIRING.

a. Description (fig. 69). The generating system wiring consists of wires connecting the generator, regulator, circuit breaker in bulk-

head terminal box, shunt, ammeter in the instrument panel, and ground terminals.

b. Replacement.

(1) GENERATOR TO REGULATOR WIRES NOS. 26 AND 27. Open master switch. Remove generator terminal box cover. Remove ends of wires from terminals. Remove regulator terminal box cover, and disconnect two wires from regulator. Attach new wires to ends of old wires, and pull new wires into harness. Connect wire No. 27 to regulator terminal marked "ARM," and wire No. 26 to the terminal marked "FIELD." Install regulator terminal box cover. Connect wires to generator (par. 88 c (3)).

(2) REGULATOR TO CIRCUIT BREAKER WIRE NO. 25. Open master switch. Remove regulator terminal box cover, and disconnect wire from terminal in small compartment of terminal box. Remove cover from conduit tee. Remove cover from bulkhead terminal box. Disconnect wire No. 25 from circuit breaker. Attach new wire to end of old wire, and draw new wire into position in conduit. Connect wire to circuit breaker terminal and to terminal marked "BATT" in regulator. Install regulator terminal box cover, bulkhead box cover, and conduit tee cover.

(3) CIRCUIT BREAKER TO SHUNT WIRE NO. 25. Open master switch. Remove bulkhead terminal box cover. Remove wire No. 25 from shunt terminal post and circuit breaker terminal post. Install new wire on terminal posts. Install terminal box cover.

(4) AMMETER TO BULKHEAD TERMINAL BOX WIRES NOS. 38 AND 39. Open master switch. Remove cover from bulkhead terminal box. Disconnect wires Nos. 38 and 39 from shunt terminal posts, and pull ends of wires free of other wires in terminal box. Remove cover from instrument panel terminal box and conduit tee. Disconnect wires Nos. 38 and 39 from terminal box. Attach new wires to old wires, and draw new wires into conduit. Connect wires to terminals in instrument panel terminal box and to shunt terminals. Remove the lower left wiring harness from the instrument panel (par. 97 b (1)). Install new harness (par. 97 d (1)).

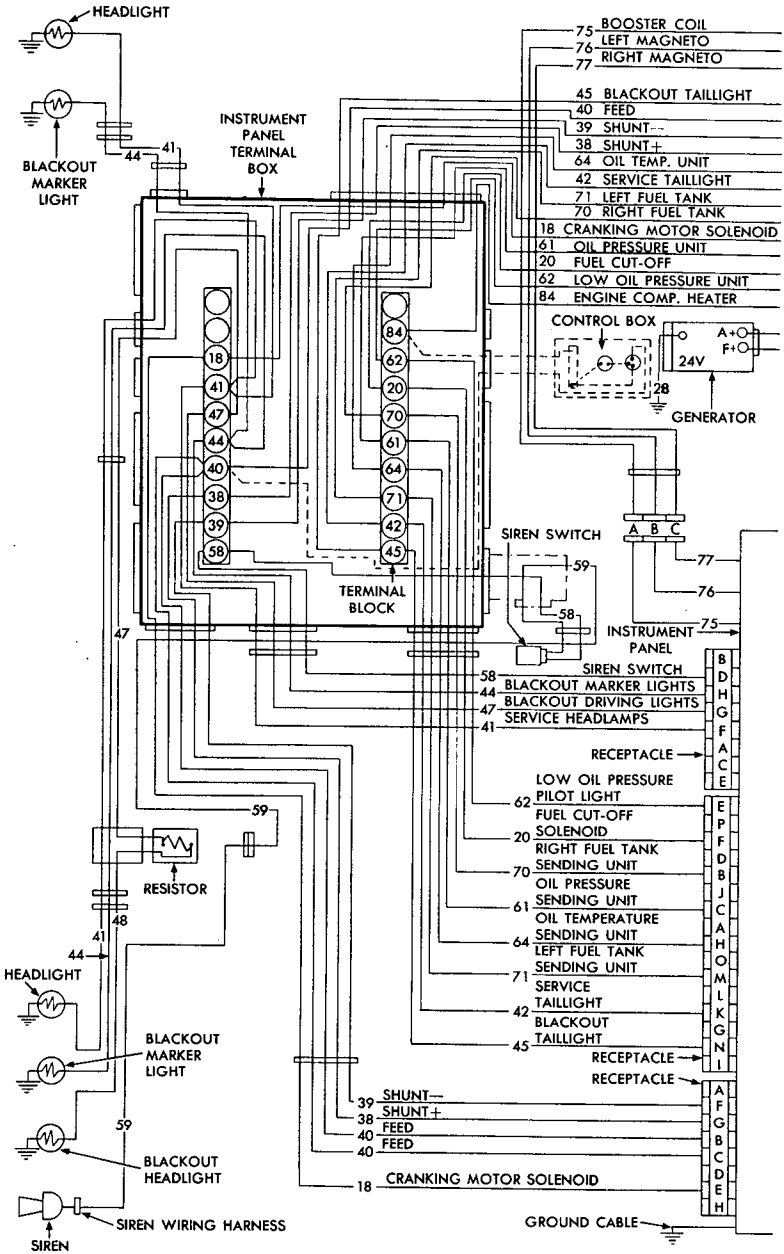
Section XXI

ELECTRICAL SYSTEM

91. DESCRIPTION (figs. 69, 70, and 71).

a. Two 12-volt batteries connected in series furnish 24 volts to the electrical system. The current is carried by wires enclosed in conduits and flexible wiring harness. There are three terminal boxes: one in the crew compartment side of the bulkhead, another in the

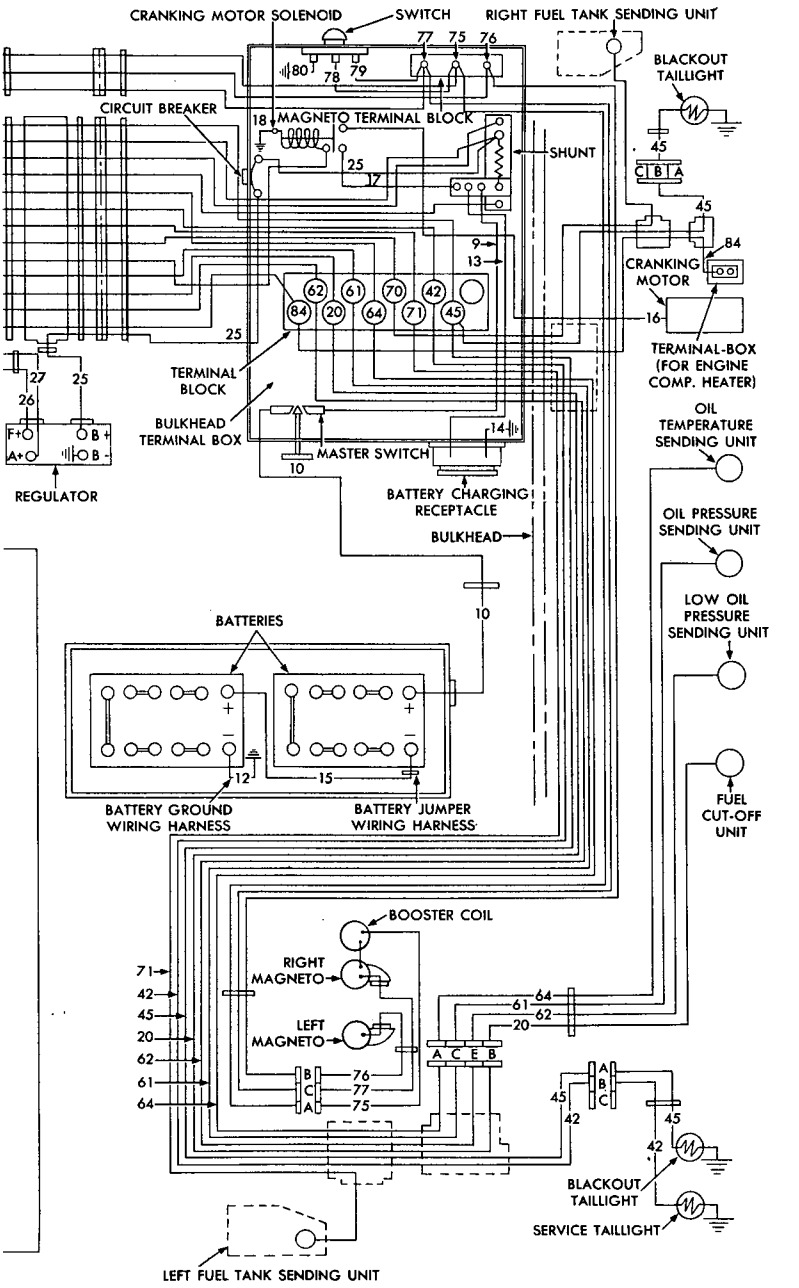
CARRIAGE, MOTOR, 105-MM HOWITZER, M7



RA PD 322426

Figure 69 — Wiring

ELECTRICAL SYSTEM



RA PD 322426B

Diagram (Late Models)

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

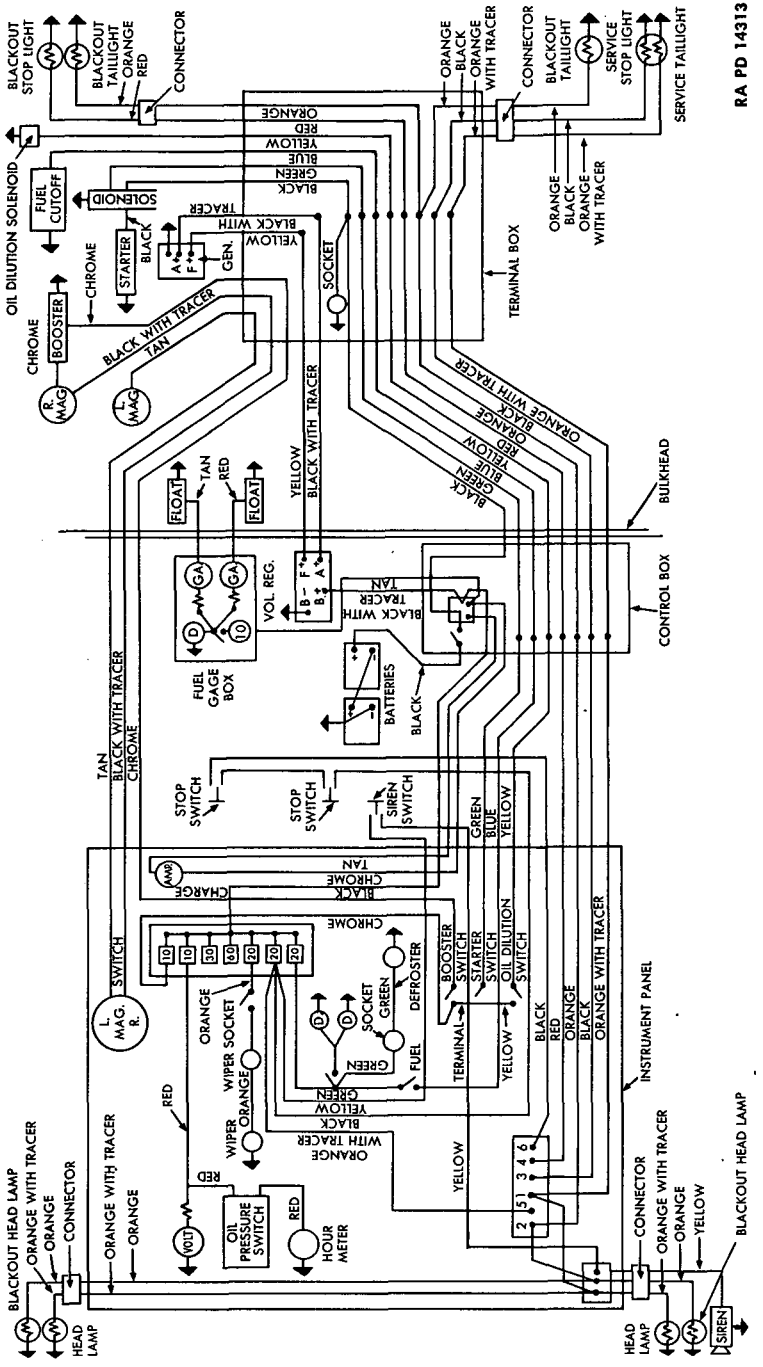


Figure 70 – Wiring Diagram (Early Models)

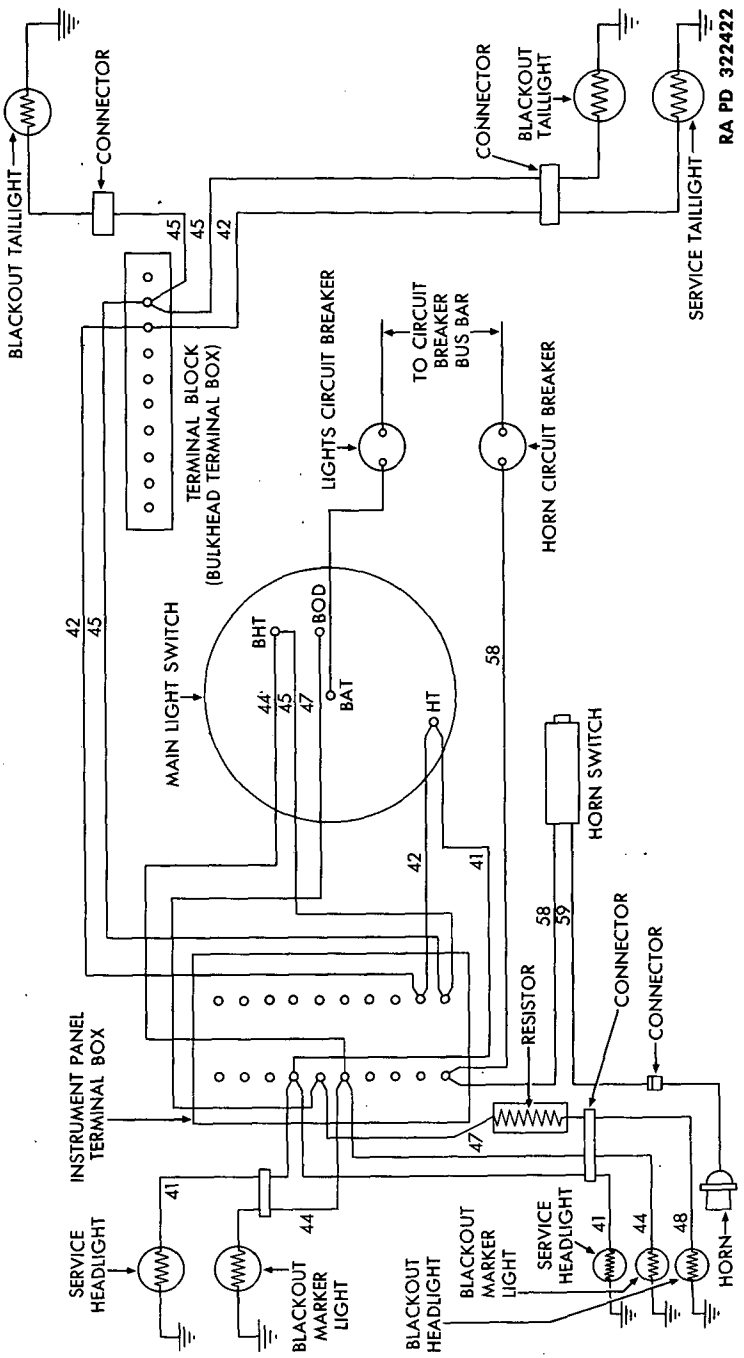


Figure 71 — Lighting System Wiring Diagram (Late Models)

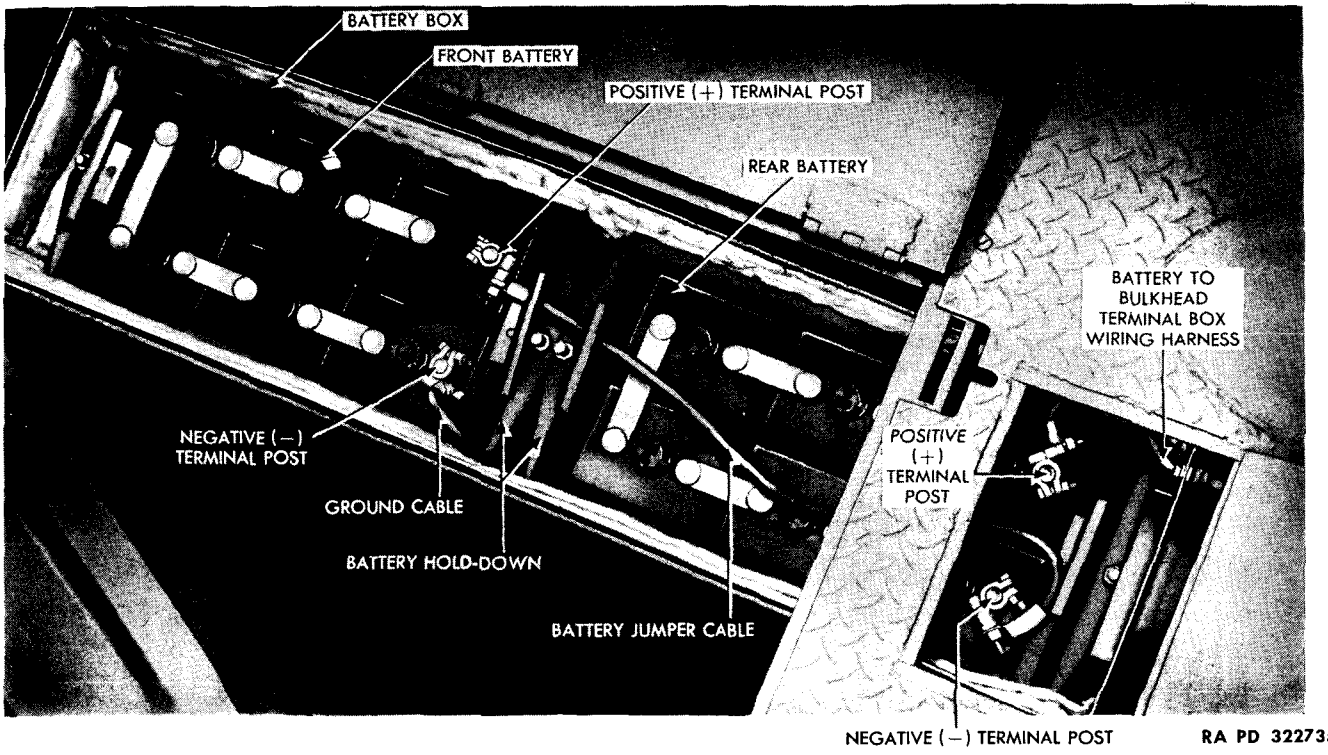


Figure 72 — Batteries Installed

front end of the hull, and a third box on the right rear wall of the engine compartment. All outside lights are controlled by a master switch on the instrument panel. Wiring is protected by circuit breakers on the instrument panel. A battery master switch is located on the bulkhead terminal box to cut the battery in or out of the circuit.

92. BATTERIES (fig. 72).

a. Maintenance.

(1) ELECTROLYTE LEVEL. Add distilled water to keep the electrolyte (battery fluid) 3/8 inch above the top of the battery plates at all times.

(2) BATTERY VOLTAGE TEST. Test each battery separately. Press the prods of the voltage tester firmly against the negative and positive posts of the cell. The voltmeter attached to the tester should indicate 1.9 to 2.2 volts for each cell in the battery.

(3) BATTERY HYDROMETER TEST. Remove the battery filler caps and test the electrolyte solution with a hydrometer. The charge in the battery (specific gravity) will be indicated by the figure on the small tube which shows just above the level of the solution. Add to, or subtract from, the reading in accordance with the temperature scale on the hydrometer to obtain the actual specific gravity. The following hydrometer readings show the condition of the battery at normal operating temperature (80° F):

Fully charged	1.275 to 1.300
Half charged	1.225
Very low	1.150

If the battery is less than half-charged, recharge or exchange for a fully charged battery.

b. Removal (fig. 72). Open crew compartment floor plates over battery box. Open battery master switch. Remove battery covers. Disconnect battery ground cable terminal and then other cable terminals from batteries. Pull jumper cable out of battery handles. Loosen battery hold-down clamp bolt nuts. Drop bolts down, rotate one-half turn, and lift out battery hold-down frames. Carefully lift out front battery, then rear battery.

c. Installation. Inspect battery box, trays, and hold-down bolts to see that they are in good condition and free of corrosion. Replace the fireproof pads if necessary. Lower one battery into the front box with positive terminal toward propeller shaft. Push battery to rear box. Lower second battery into position in similar manner. Install hold-down frames and frame bolt nuts. Place battery jumper cables through center handles of batteries and on battery posts. Install ground cable on negative post of front battery, and battery to

terminal box cable on positive post of rear battery. Tighten terminal nuts securely with a toothed lock washer between the terminal nut and the cable terminal. Coat the exposed surfaces of the terminals with petrolatum or general purpose grease to prevent corrosion, and install battery covers. Close crew compartment subfloor plates.

d. Preparing Dry Charged Batteries for Service. Plates in batteries shipped dry are in a partly charged condition. It is important that vent plugs be left tightly in place until battery is to be filled. The electrolyte to be used for filling is diluted sulphuric acid. It must be pure, suitable for storage battery use, and of 1.270 specific gravity. CAUTION: *The temperature of the filling electrolyte must not exceed 90° F (32° C).* To prepare battery for service, proceed as follows:

(1) Remove masking tape over small hole in vent plug, leaving the small hole open. Unscrew vent plugs.

(2) Fill each cell with prepared electrolyte to the protector on top of the separators.

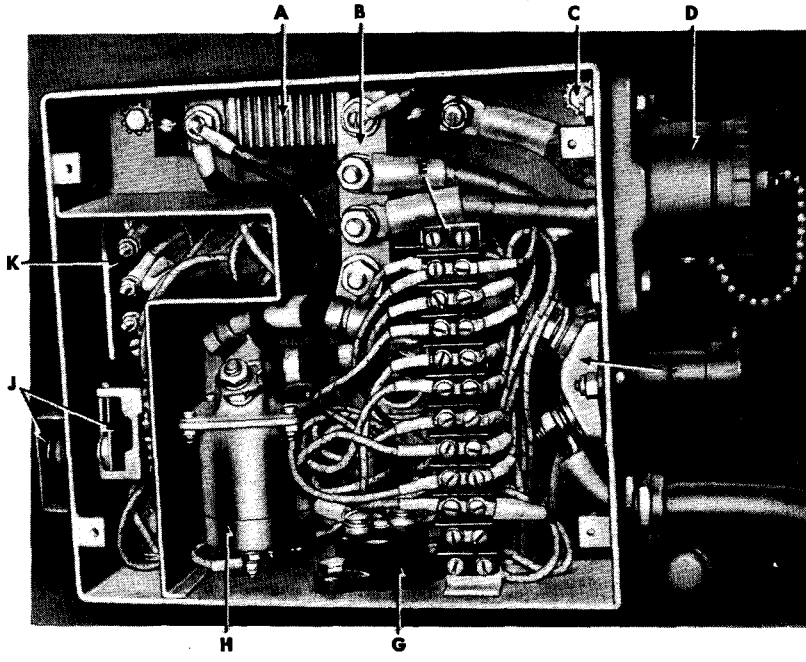
(3) Allow battery to stand at least 1 hour after filling with electrolyte. If level has fallen, add electrolyte to restore it. Replace vent plugs in cells. If any electrolyte was spilled on battery, remove by means of a cloth slightly dampened with a solution of bicarbonate of soda and water.

(4) A freshening charge of 13 amperes must be given the battery before placing it in service. Make certain that positive terminal of battery is connected to the positive of the charging circuit, and negative terminal of battery is connected to the negative of the charging circuit.

(5) Charge unit until four consecutive hourly readings show no rise in specific gravity and voltage for the lowest cell. If above rate is maintained, length of charging time will be at least 12 hours; lower rates will increase the time proportionately. If temperature exceeds 110° F, reduce charging rate. If necessary to restore electrolyte level during charge, use only approved water.

(6) After completion of charge, the gravity should be between 1.270 and 1.285, corrected to 77° F, and with the level 3/8 inch above protector on top of separators. If it is not, adjust by removing some solution and replacing with approved water or electrolyte as required. Charge to mix solution before testing again.

e. Replace Battery Cables. Remove front battery (par. 92 b). Disconnect ground cable from ground terminal post. Disconnect cable from positive post of rear battery. Remove cover from bulkhead terminal box. Disconnect cable from lower part of battery master switch. Pull cable out of conduit. Insert new cable in conduit, and pull it into position, using wire threaded through conduit.



A—SHUNT
B—BUS BAR
C—MOUNTING CAP SCREW
D—RECEPTACLE
E—TERMINAL BLOCK
F—MASTER SWITCH
G—CIRCUIT BREAKER
H—CRANKING MOTOR SOLENOID
J—EMERGENCY STOP SWITCH
K—MAGNETO TERMINAL BLOCK

RA PD 322742

Figure 73 — Bulkhead Terminal Box (Late Models)

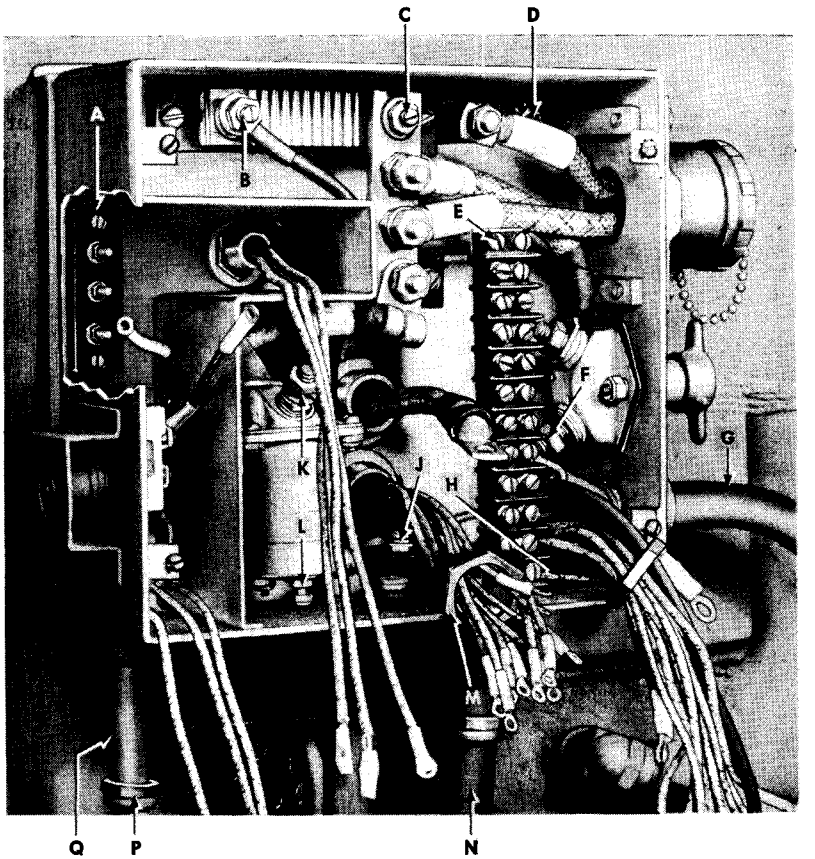
Attach upper end of cable to battery master switch lower terminal. Attach battery end of cable to positive post of rear battery. Attach ground cable to terminal post in bottom of battery box. Install front battery (subpar. c above).

93. BULKHEAD TERMINAL BOX (fig. 73).

a. Description. The bulkhead terminal box is mounted on the crew compartment side of the bulkhead. It provides a housing for the battery master switch, battery charging receptacle, generating system circuit breaker, shunt, cranking motor solenoid switch, emergency stop switch, and the terminal blocks for connecting the wires of the various circuits. The contents of the box are accessible by removing the cover.

b. Removal (fig. 74). Remove front battery cover. Remove ground cable from battery, and wrap cable terminal with tape to

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A—MAGNETO TERMINAL BLOCK (ALL WIRES)
B—SHUNT TERMINAL (WIRES 38, 40)
C—SHUNT TERMINAL (WIRE 39)
D—MOUNTING CAP SCREW
E—TERMINAL BLOCK (ALL WIRES)
F—MASTER BATTERY SWITCH TERMINAL (WIRE 10)
G—BATTERY WIRING CONDUIT
H—RADIO INTERFERENCE SUPPRESSION GROUND WIRE
J—CIRCUIT BREAKER TERMINAL (WIRE 25)
K—CRANKING MOTOR RELAY TERMINAL (WIRE 16)
L—CRANKING MOTOR RELAY TERMINAL (WIRE 18)
M—LOCK NUT
N—TERMINAL BOXES WIRING CONDUIT
P—CONNECTOR BODY
Q—MAGNETO FRONT WIRING CONDUIT

RA PD 322855

Figure 74 — Disconnections For Removing Bulkhead Terminal Box

prevent accidental contact with battery. Remove terminal box cover. Remove terminal block screws and wires. Install screws. Remove wire No. 25 from circuit breaker terminal; wires Nos. 38, 39, and 40 from shunt terminals; wires Nos. 18 and 16 from cranking motor relay switch. Straighten wires so they will pass through conduit. Remove eight wires from magneto terminal block. Remove cable from lower terminal of battery master switch. Remove lock nuts from ends of six conduits inside terminal box. Pull conduits away from box. Remove terminal box mounting bolts and toothed lock washers, together with the ground wires for the emergency stop switch and the radio interference suppression system. Lift terminal box away from bulkhead. Remove all switches, fittings, and terminal blocks from the terminal box.

c. Installation (fig. 74). Install all fittings, switches, and terminal blocks if removed from the old box. Insert the conduit wires through the adjacent terminal box fittings, and attach the conduits. Remove paint from bulkhead and terminal box where mounting screw toothed lock washers contact. Mount the terminal box on the bulkhead with a toothed lock washer under the heads of the screws and between the bulkhead and the terminal box. Place ground wires for emergency stop switch and radio interference suppression under the heads of the two lower mounting cap screws. Install cable No. 10 on lower terminal of battery master switch. Install wires Nos. 75, 76, 77, 78, and 79 on magneto terminal block, as shown on figure 30. Connect wires Nos. 16 and 18 to the cranking motor relay switch; Nos. 38, 39, and 40 to the shunt terminals; wire No. 25 to the circuit breaker terminal. Install battery ground cable on negative post of front battery. Install cover on front battery.

d. Remove Units From Bulkhead Terminal Box.

(1) DISCONNECT BATTERY GROUND CABLE. Remove front battery cover. Remove ground cable from battery, and wrap cable terminal with tape to prevent accidental contact with battery. Remove terminal box cover.

(2) REMOVE TERMINAL BLOCK (E, fig. 73). Remove the screws and toothed lock washers securing wires to terminal block. Remove four screws and lock washers attaching top and bottom of terminal block to support bracket. Lift out terminal block.

(3) REMOVE MASTER SWITCH (F, fig. 73). Remove screw from end of master switch control handle on outside of terminal box, and lift off control handle. Remove nut and lock washer from lower terminal on switch, and lift off positive battery cable. Remove nut and lock washer from upper terminal on switch, and lift off cable leading to bus bar. Remove two nuts, lock washers, and bolts securing switch to terminal box. Pull switch inside terminal box, and out. Lift switch gasket out of terminal box.

(4) REMOVE RECEPTACLE (D, fig. 73). Remove nut and toothed lock washer securing positive receptacle cable to bus bar terminal, and lift off cable. Remove receptacle ground cable from ground post by removing nut and lifting off cable. Lift internal-external toothed washer off ground post. Remove four cap screws and toothed lock washers attaching receptacle to bulkhead terminal box. Lift off receptacle with attached cables.

(5) REMOVE BUS BAR (B, fig. 73). Remove front nut and toothed lock washer from bottom bus bar terminal, and lift off cable leading to cranking motor solenoid. Remove positive shunt wire from right-hand shunt terminal at top of bus bar by removing nut and toothed lock washer. Remove cable, which ran to upper master switch terminal from bus bar terminal, by removing nut and internal-toothed washer. Remove two screws and lock washers attaching lower bus bar insulator block to rear of bulkhead terminal box, and lift out bus bar and insulator block.

(6) REMOVE SHUNT (A, fig. 73). Remove nut and lock washer from left shunt terminal, and lift off negative shunt wire, feed wire, and negative shunt to circuit breaker wire. Remove screw and toothed lock washer from each end of shunt insulator, and lift insulator with attached shunt off insulator bracket.

(7) REMOVE BULKHEAD ENGINE EMERGENCY STOP SWITCH (J, fig. 73). Slide rubber grommet off nut and switch plunger outside bulkhead terminal box. Pry spring off end of switch plunger. Remove brass nut and flat washer securing switch to terminal box; then push switch through to the inside. Lift off fiber washer. Disconnect three wires from switch terminals by removing screws and lock washers.

(8) REMOVE MAGNETO TERMINAL BLOCK (K, fig. 73). Remove nut, toothed lock washer, and flat washer from top terminal, and lift off two booster coil wires. Remove nut, toothed lock washer, and flat washer from center terminal, and lift off two left magneto wires and one wire which led to the engine emergency cut-off switch. Remove nut, toothed lock washer, and flat washer from bottom terminal, and lift off two right magneto wires and one wire which led to the engine emergency cut-off switch. Remove screw from top and bottom of terminal block. Lift out terminal block.

(9) REMOVE CRANKING MOTOR SOLENOID (H, fig. 73). Remove lock nut which attaches solenoid to cranking motor cable to solenoid terminal. Remove lock nuts which attach ground wire and cranking motor switch wire to lower terminals on solenoid. Remove nuts and internal-toothed washers attaching solenoid base to bulkhead terminal box. Lift out solenoid with short cable on left-hand terminal attached.

(10) REMOVE WIRES FROM CIRCUIT BREAKER (G, fig. 73). Remove screws and lock washers attaching shunt to circuit breaker, and generator regulator to circuit breaker wires to two terminals on top of the circuit breaker. Remove circuit breaker retaining screws and lift off circuit breaker.

e. Install Units in Bulkhead Terminal Box.

(1) INSTALL CIRCUIT BREAKER (fig. 73). Attach circuit breaker to inside bottom of terminal box, with two screws. Attach circuit breaker to shunt wire, to left-hand terminal, and circuit breaker to generator regulator wire, to right-hand terminal on circuit breaker (25, fig. 69) with screws and lock washers.

(2) INSTALL CRANKING MOTOR SOLENOID (fig. 73). Attach solenoid base to back of terminal box with internal-toothed washers and nuts. Attach ground wire (18, fig. 69) to bottom rear terminal on solenoid and starting switch wire (18, fig. 69) to bottom front terminal on solenoid. Attach solenoid to cranking motor cable (16, fig. 69) to top front terminal on solenoid with flat washer and lock nut. See that short cable (17, fig. 69) which runs to the bottom bus bar terminal is secured to the rear top solenoid terminal.

(3) INSTALL MAGNETO TERMINAL BLOCK (fig. 73). Attach magneto terminal block to terminal box with flathead screws. Attach one wire (79, fig. 69) which will be connected to the engine emergency cut-off switch, and two right magneto wires (77, fig. 69) to bottom terminal on block. Attach one wire (78, fig. 69) which will be connected to the engine emergency cut-off switch, and two left magneto wires (76, fig. 69) to center terminal on block. Attach two booster coil wires (75, fig. 69) to top terminal on block. Secure wires to their terminals with flat washers, lock washers, and nuts.

(4) INSTALL BULKHEAD ENGINE EMERGENCY STOP SWITCH (fig. 73). Attach ground wire (80, fig. 69) to center terminal, wire from center terminal of terminal block (78, fig. 69) to upper left terminal, and wire from bottom terminal of terminal block (79, fig. 69) to upper right terminal of emergency cut-off switch with screws and lock washers. Position fiber washer around opening inside terminal box; then position cut-off switch against washer. Secure switch from the outside with flat washers and brass nut. Install spring over switch plunger. Install rubber grommet over spring, spring plunger, and brass nut.

(5) INSTALL SHUNT (fig. 73). Attach shunt insulator with attached shunt to bracket at rear of terminal box with internal-toothed washers and screws. Attach negative wire from circuit breaker (25, fig. 69), feed wire (40, fig. 69), and negative shunt wire (38, fig. 69) to right shunt terminal with lock washer and nut.

(6) INSTALL BUS BAR (fig. 73). Secure insulator block with attached bus bar to bracket in terminal box with lock washers and screws. Attach positive shunt wire (39, fig. 69), extending from conduit tube in lower right corner, to right-hand shunt terminal above bus bar with internal toothed washers and nut. Attach cable (17, fig. 69), extending from cranking motor solenoid, to bottom terminal on bus bar with internal-toothed washer and nut. Attach cable which will run to battery master switch to second top terminal on bus bar, with internal-toothed washer and nut.

(7) INSTALL RECEPTACLE (fig. 73). Insert cables attached to receptacle into opening in terminal box. Attach receptacle to terminal box with four internal-toothed washers and cap screws. Position external-toothed washer on ground post at rear of terminal box; then secure receptacle ground cable (14, fig. 69) to ground post with a nut. Secure positive receptacle cable (13, fig. 69) to bus bar terminal with lock washer and nut.

(8) INSTALL MASTER SWITCH (fig. 73). Position gasket around opening inside terminal box. Position switch against gasket and secure to terminal box with bolts, lock washers, and nuts. Attach positive battery cable (10, fig. 69) extending from conduit tube below, to lower terminal on switch with lock washer and nut. Attach cable, extending from center terminal on bus bar, to upper terminal on switch with lock washer and nut. Install switch control handle on outside of terminal box.

(9) INSTALL TERMINAL BLOCK (fig. 73). Attach terminal block to support bracket with two lock washers and screws at top and bottom. Attach wires to terminal block, using the wiring diagram (fig. 69) as a guide.

(10) CONNECT BATTERY GROUND CABLE. Connect ground battery terminal to negative post of front battery. Turn master switch to the "ON" position and test circuits for operation. Install battery and terminal box covers. Replace floor plates.

94. ENGINE COMPARTMENT TERMINAL BOX.

a. Description (fig. 81). The terminal box, mounted on the right rear inside wall of the engine compartment, provides a convenient connection for the engine oil heater. It is connected by wire No. 84 to the heater control box (supplied in a field service kit) in the crew compartment.

b. Removal. Remove the terminal box cover. Disconnect leads from terminals. Loosen harness elbow connection and remove attaching screws. Lift off terminal box.

c. Installation. Place terminal box against hull wall with toothed lock washers between hull and box on clean surface. Install mount-

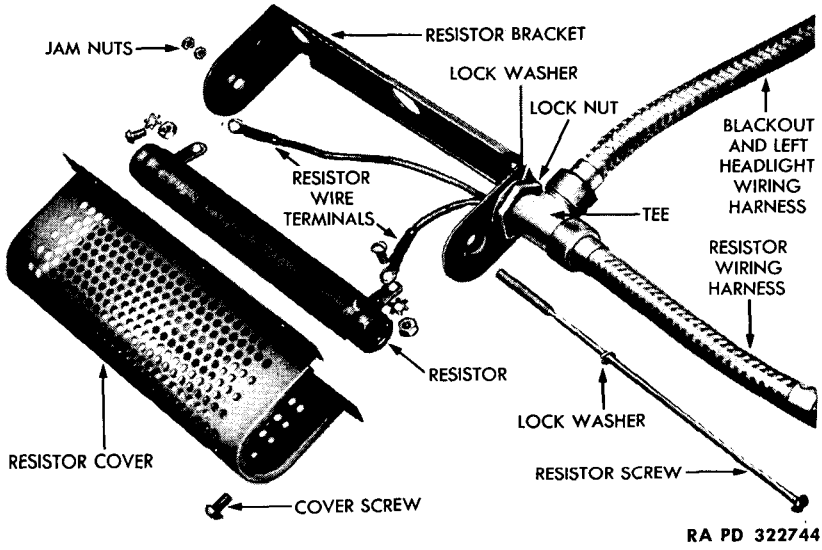


Figure 77 — Resistor Box Assembly

b. Removal (fig. 76). Open battery master switch in bulkhead terminal box. Loosen instrument panel and move panel aside. Remove bolts from resistor box cover and lift off cover. Remove bolt through center of resistor. Remove wire terminals from resistor and lift off resistor.

c. Installation. Place resistor in bracket and install bolt, lock washer, and resistor bolt nuts. Install wire terminals, Nos. 47 and 48, on resistor using toothed lock washer under terminal bolt nut. Place resistor cover on bracket and install screws.

97. WIRING CONDUITS.

a. Description. The wiring conduit assemblies are made of lengths of metal conduit, flexible harnesses, and fittings most adaptable to the location and purpose. The assemblies are equipped with multiple connectors and fittings to simplify attachment to the terminal boxes, and for joining the wiring to the instrument panel or other conduits or harnesses. All are securely attached to the hull with clips or clamps, and toothed lock washers, to provide a bond for radio interference suppression. All flexible conduits are shielded.

b. Removal of Wiring Conduit Assemblies.

(1) INSTRUMENT PANEL TERMINAL BOX TO BULKHEAD TERMINAL BOX CONDUIT (figs. 74 and 75). Open battery master switch. Remove cover from instrument panel terminal box, and disconnect all wires which pass through the conduit from the terminal block.

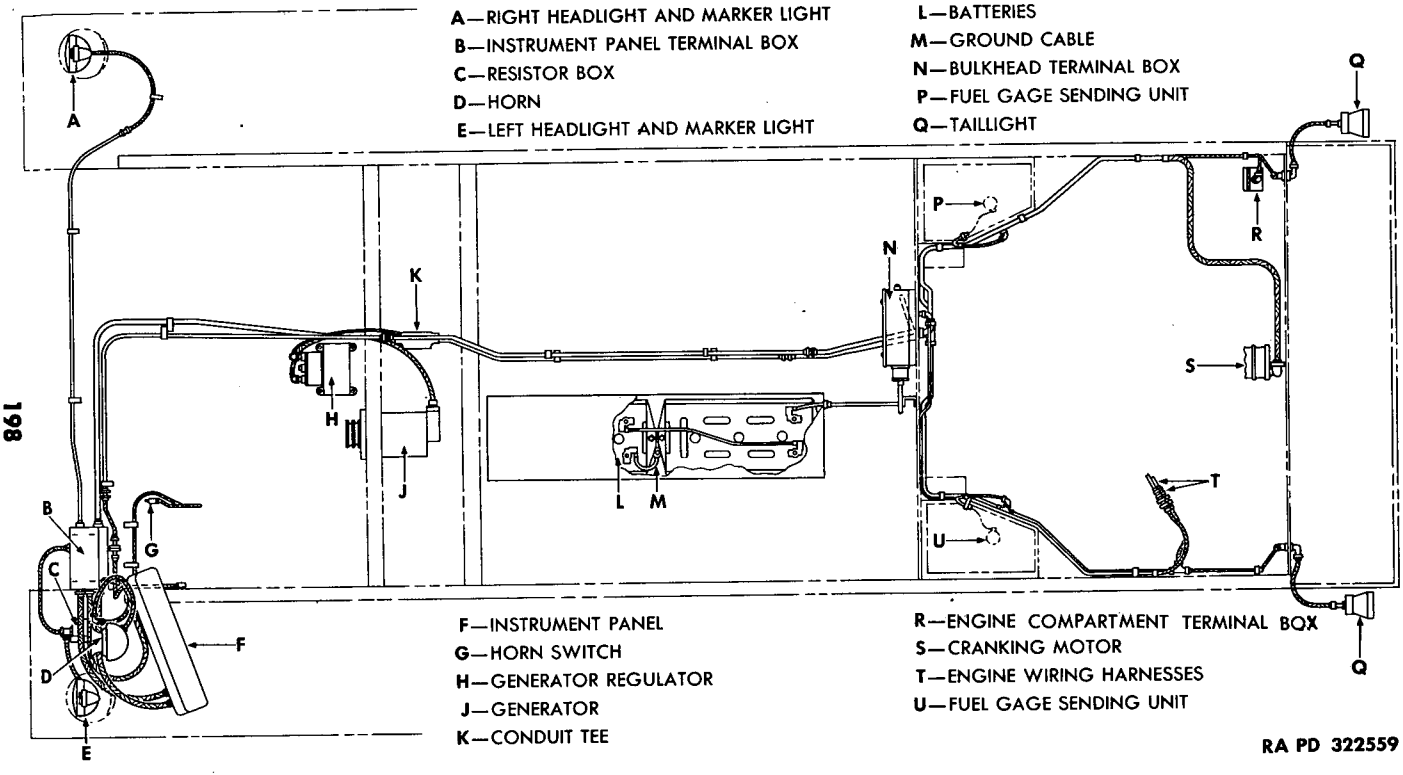
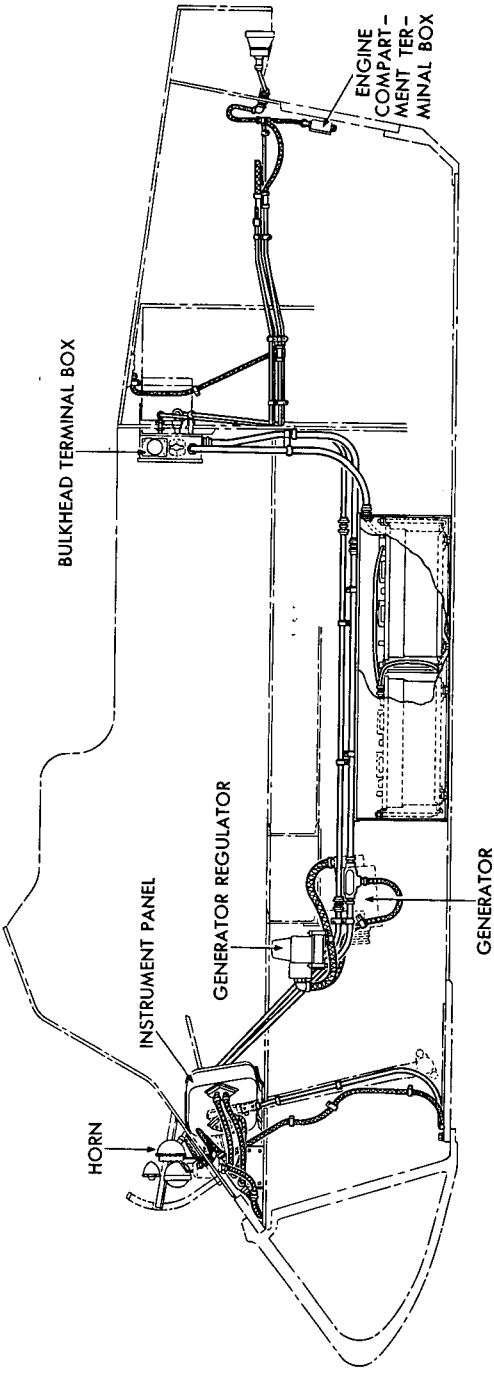


Figure 78 — Wiring Harnesses and Conduits Layout, Top View



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Figure 79 — Wiring Harnesses and Conduits Layout, Side View

Remove conduit lock nut over ends of wires. Remove cover from conduit tee, and pull wires back out of conduit (or cut wires if same wires will not be installed). Disconnect regulator to circuit breaker wiring harness from regulator terminal (par. 90 b (2)). Disconnect conduit ahead of conduit tee. Remove clips and lift conduit out of vehicle. Remove bulkhead terminal box cover, and disconnect terminals of all wires which pass through conduit. Remove conduit lock nut inside terminal box. Disconnect two sections of conduit at connection under crew compartment subfloor. Pull out two sections of conduit from hull.

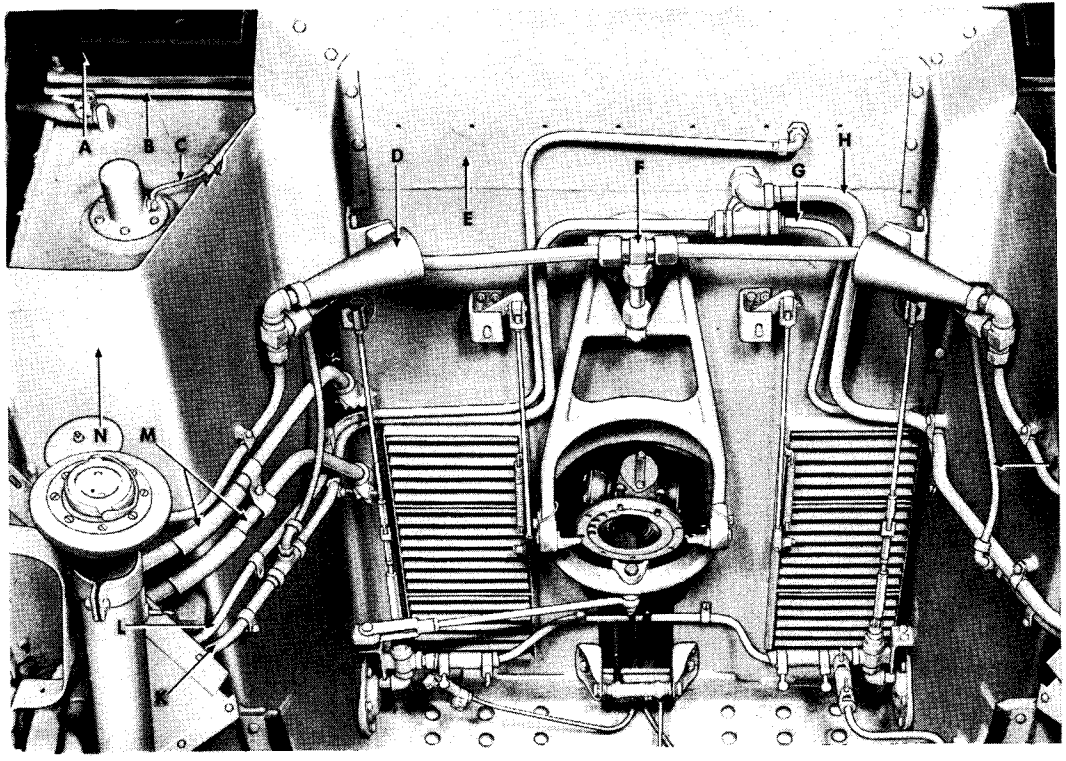
(2) FRONT MAGNETO WIRING CONDUIT (figs. 76, 78, and 79). Open battery master switch. Disconnect flexible harness from the instrument panel at the connector (fig. 76). Remove clip bolt and toothed lock washers. Remove cover from bulkhead terminal box, and disconnect all wires from magneto terminal block which pass through conduit. Loosen conduit lock nut, and pull conduit away from terminal box. Disconnect conduit section near rear of battery box and near front end of propeller shaft. Remove attaching clips, and remove conduit in sections from the hull.

(3) BATTERY WIRING CONDUIT (fig. 78). Open battery master switch. Remove battery ground cable from terminal post. Remove bulkhead terminal box cover. Disconnect both battery wires from battery and battery master switch. Remove lock nuts at each end of conduit; remove attaching clip and pull out conduit.

(4) RIGHT HEADLIGHT WIRING HARNESS (fig. 78). Open battery master switch. Remove instrument panel terminal box cover. Disconnect from terminal block the wires coming from the right headlight harness. Remove conduit lock nut. Pull out tool box in right front corner of crew compartment. Unscrew coupling nut, and pull out connector plug at headlight. Remove attaching clips. Remove harness assembly from vehicle.

(5) LEFT HEADLIGHT AND RESISTOR WIRING HARNESS. Open the battery master switch. Remove instrument panel (par. 98). Remove resistor box (par. 96). Remove cover from instrument panel terminal box. Loosen coupling nut which secures resistor and left headlight wiring harness. Disconnect wires from terminal block. Loosen harness coupling nut at connector plug, and pull out connector plug. Remove wiring harness.

(6) HORN AND HORN SWITCH WIRING HARNESS (figs. 7 and 76). Open battery master switch. Remove instrument panel terminal box cover, and disconnect switch wire from the terminal block. Back off harness lock nuts from inside terminal box. Loosen harness elbow nut at hull under horn, and pull out connector plug. Remove clips which secure harness to hull. Remove horn switch from steering



A—HOLD-DOWN BRACKET

B—HOLD-DOWN PLATE

C—SENDING UNIT WIRE

D—FIRE EXTINGUISHER NOZZLE

E—BULKHEAD

F—FIRE EXTINGUISHER LINE TEE

G—FUEL TANK, TAILLIGHT, AND ENGINE COMPARTMENT HEATER WIRING CONDUIT

H—CRANKING MOTOR WIRING CONDUIT

J—SENDING UNIT WIRING HARNESS

K—FUEL TANK, TAILLIGHT, AND ENGINE INSTRUMENTS WIRING CONDUIT

L—ENGINE MAGNETO WIRING CONDUIT

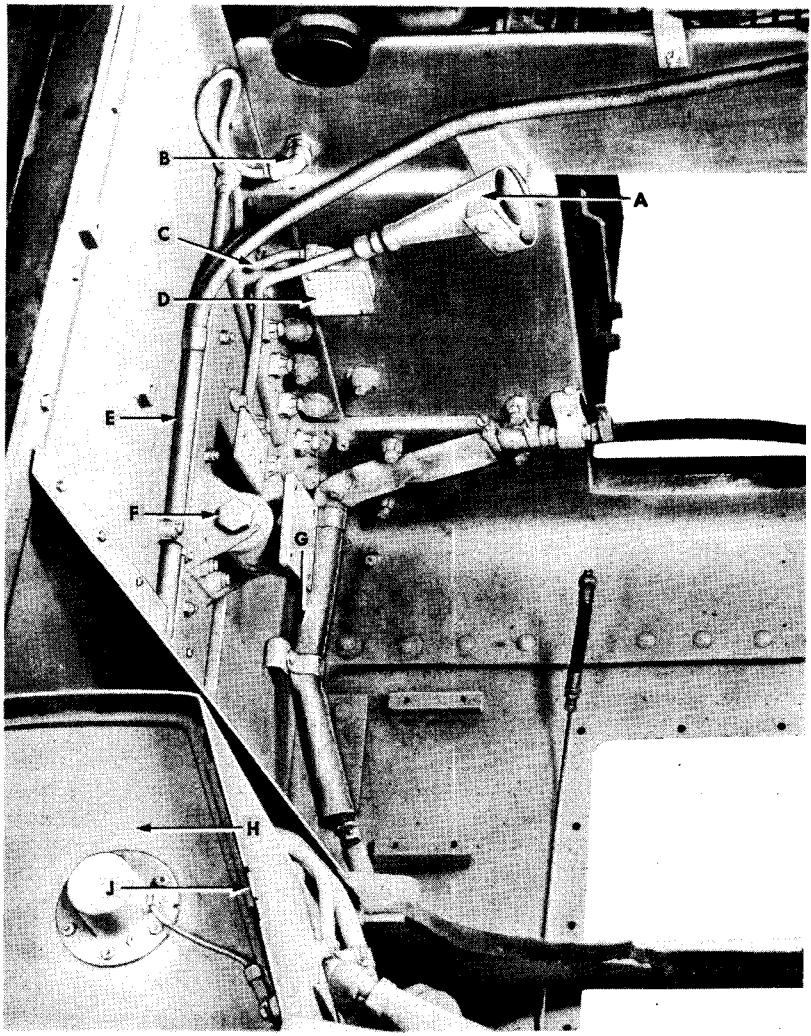
M—OIL COOLER LINES

N—LEFT VERTICAL FUEL TANK SHIELD

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Figure 80 — Wiring Harnesses in Front End of Engine Compartment

CARRIAGE, MOTOR, 105-MM HOWITZER, M7



A—FIRE EXTINGUISHER NOZZLE
B—RIGHT TAILLIGHT WIRING HARNESS
C—TERMINAL BOX WIRING HARNESS
D—TERMINAL BOX (ENGINE COMPARTMENT HEATER)
E—CRANKING MOTOR WIRING HARNESS
F—ENGINE SUPPORT BEAM BRACKET BOLT
G—FUEL SUPPLY LINE TO FUEL PUMP
H—RIGHT VERTICAL FUEL TANK
J—FUEL TANK SHIM

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Figure 81 — Wiring Harnesses in Right Rear End of Engine Compartment

brake lever by removing two attaching bolts. Pull harness down under subfloor and out of vehicle.

(7) INSTRUMENT PANEL WIRING HARNESSES (fig. 76). Open battery master switch. Remove instrument panel (par. 98). Remove cover from instrument panel terminal box. Disconnect ends of wires from terminal block which enter harnesses. Unscrew coupling nuts at terminal box. Pull out wires and lift out harnesses.

(8) GENERATOR TO REGULATOR WIRING HARNESS (fig. 68). Disconnect harness from generator (par. 88 b). Remove the regulator terminal box cover. Disconnect wire No. 25 from the right-hand terminal. Unscrew harness coupling nut. Remove harness clip and lift out harness.

(9) REGULATOR TO CIRCUIT BREAKER WIRING HARNESS (fig. 68). Disconnect harness from regulator by removing terminal box cover and disconnecting wires Nos. 26 and 27. Unscrew harness coupling nut from regulator. Remove cover from conduit tee (fig. 78). Disconnect wiring harness from conduit tee. Pull wire out of harness. Remove harness attaching clip and lift out harness.

(10) FUEL TANK, TAILLIGHT, AND ENGINE INSTRUMENTS WIRING CONDUIT (K, fig. 80). Remove engine (par. 51). Remove cover from bulkhead terminal box and disconnect, from terminal block, all wires which pass through conduit. Disconnect conduit from tee on bulkhead. Pull conduit wires back out of bulkhead terminal box. Disconnect sending unit wire from sending unit. Remove sending unit wire harness clips from fuel tank shield. Remove lower left engine shroud seal attaching screws, and lift off shroud and seal. Remove shut-off valve control rod. Disconnect engine oil cooler lower tube from cooler. Loosen all conduit connections and remove clips. Disconnect left taillight wiring harness from left taillight. Remove conduit assembly.

(11) ENGINE MAGNETO WIRING CONDUIT (L, fig. 80 and N, fig. 43). Remove engine (par. 51). Remove cover from bulkhead terminal box, and disconnect all wires passing through conduit from magneto terminal block. Disconnect conduit from elbow on bulkhead, and pull wires back out of terminal box. Remove lower engine shroud and shroud seal attaching screws, and lift off lower engine shroud. Remove shut-off valve control rod. Disconnect engine oil cooler lower tube from cooler. Loosen all conduit connections and remove clips. Remove conduit assembly.

(12) FUEL TANK, TAILLIGHT, AND ENGINE COMPARTMENT HEATER WIRING CONDUIT (figs. 80 and 81). Remove engine (par. 51). Remove cover from bulkhead terminal box and disconnect, from terminal block, all wires which pass through conduit. Disconnect conduit from tee on bulkhead. Pull conduit wires out of back

of bulkhead terminal box. Disconnect sending unit wire from sending unit. Remove sending unit harness clips from fuel tank shield. Remove lower right engine shroud and seal attaching screws, and remove shroud and seal. Remove shut-off valve control rod. Remove right taillight wiring harness from taillight connector. Remove cover from terminal box and disconnect wire from box. Loosen all conduit connections and remove clips. Lift out conduit.

(13) CRANKING MOTOR WIRING CONDUIT. Remove engine (par. 51). Remove cover from bulkhead terminal box, and disconnect the cranking motor cable from the cranking motor solenoid switch. Remove the lower right engine shroud and shroud seal screws, and lift out the shroud and seal. Remove the shut-off valve control rod. Loosen all conduit connections and remove clips. Lift out the conduit.

c. Replacement of Wiring. Open battery master switch. Disconnect each end of wire from terminal box or electrical unit. Remove terminal fitting from wire to permit wire to be drawn through conduit. Attach new wire to one end of old wire, and pull new wire into place by pulling out old wire. Detach old wire. Disconnect sections of long conduits, and pull new wire into place through one conduit section at a time to prevent breaking the wire. Attach same identifying number to each end of new wire and attach terminal fittings, if used. If wire is soldered to connector, strip the insulation from wire far enough to allow wire to be inserted in the fitting, and twist strands of wire together. Insert and solder wire. Tighten conduit connector lock nuts if loosened, and connect ends of wire to terminal blocks or electrical unit.

d. Installation of Wiring Conduit Assemblies.

(1) INSTRUMENT PANEL TERMINAL BOX TO BULKHEAD TERMINAL BOX CONDUIT (figs. 75 and 74). Place conduit sections in position in the hull. If wires have been removed, assemble the conduit wires as shown in figure 69. Insert a piece of wire or string in the conduit end section, and use wire or string to draw the wires through the conduit. Draw the regulator end of wire No. 25 out through the tee fitting so that it can be lead to the regulator, as described in step (9) below. Insert the ends of the wires and the ends of the conduit in the terminal boxes. Start the conduit connector body and lock nut at each terminal box. Connect the sections of conduit, but do not draw the lock nuts tight. Connect the wiring according to previous identification, or use the number code shown on the wiring diagrams in this section. On early models, follow the color code. Install clips and clamps on conduit, making sure toothed lock washer is under head of clip screw in contact with unpainted surface of clip. Tighten all conduit lock nuts. Test circuits for operation. Install terminal box covers and tee cover.

ELECTRICAL SYSTEM

(2) FRONT MAGNETO WIRING CONDUIT (figs. 76, 78, and 79). Place the sections of the wiring conduit in position in the hull. If wires have been removed, draw them through conduit (step (1) above). Insert rear end of wires and conduit in the bulkhead terminal box, and start connector body and lock nut. Connect section of conduit but do not draw lock nuts tight. Attach ends of wires to terminal box. If front ends of wires have been removed from harness connector, solder ends into connector terminals (step (1)). Attach conduit clips. Connect harness to instrument panel connector and test circuit (step d (1) above).

(3) BATTERY WIRING CONDUIT (figs. 78 and 79). Insert battery cable in conduit, if removed. Place conduit in hull. Install conduit clip. Tighten conduit connector body and lock nut at battery box and terminal box. Connect ends of cable to battery switch and rear battery positive terminal. Install battery ground cable in negative post of front battery. Test circuit, using low voltage circuit tester.

(4) RIGHT HEADLIGHT WIRING HARNESS (figs. 78 and 79). Insert wires, according to wiring diagram, into conduit. Install headlight connector plug on wire. Place conduit in position in hull. Insert wires and left end of conduit in instrument panel terminal box, and start the conduit connector body and lock nut. Insert the connector plug at the headlight connector socket, and tighten the coupling nut. Attach wires to terminal block opposite wires with same numbers. Install conduit clips. Test the circuit, using low voltage circuit tester. Install cover on terminal box.

(5) LEFT HEADLIGHT AND RESISTOR WIRING HARNESS. If wiring has been removed from harness, insert wires, according to wiring diagram (fig. 69), in left headlight wiring harness and in resistor wiring harness. Connect wiring harness coupling nuts to tee fitting. Install tee fitting on resistor bracket, with toothed lock washer between bracket and tee lock nut, contacting unpainted metal. Install left headlight connector plug on end of wire, if removed. Install connector plug in headlight connector socket, and tighten connector nut. Insert ends of wires in instrument panel terminal box lower opening, and attach wires with numbers matching wires on terminal block. Tighten lock nut inside terminal box. Install resistor box (par. 96 c). Test the circuit. Install instrument panel (par. 98 d). Install terminal box cover.

(6) HORN AND HORN SWITCH WIRING HARNESSES. If wires have been removed from harnesses, pull wires into harnesses according to wiring diagram, figure 69. Place harnesses in hull, with horn switch harness going down left sponson, under subfloor, and up the right steering brake lever. Attach clips, and install horn switch by means of two attaching bolts. Insert wires in opening in upper side of instrument panel terminal box, and draw up lock nut which secures

elbow to terminal box. Attach wire No. 58 to terminal block opposite matching number. Insert horn connector plug in socket under horn, and install elbow in hull. Test circuit. Install terminal box cover.

(7) INSTRUMENT PANEL WIRING HARNESSES (fig. 75). Place the harnesses at their correct openings in the instrument panel terminal box. Insert the wires and connect the wires to the terminal block with numbers matching wires on block. Draw up the coupling nuts. Install instrument panel (par. 98 d). Test circuits. Install terminal box cover.

(8) GENERATOR TO REGULATOR WIRING HARNESS (fig. 68). Install wires (fig. 69) in harness. Attach harness to hull bracket with harness clip. Connect wires and harness to regulator (par. 89 c); connect wires and harness to generator (par. 88 c (3)).

(9) REGULATOR TO CIRCUIT BREAKER WIRING HARNESS (fig. 68). Install wire No. 25 from conduit tee, described in paragraph 97 d (1), in wiring harness. Connect wire and harness to regulator (par. 89 c). Install connector nut on conduit tee.

(10) FUEL TANK, TAILLIGHT, AND ENGINE INSTRUMENTS WIRING CONDUIT (fig. 80). If wires have been removed from conduit, draw wires according to figure 69, into conduit and flexible harnesses. Tighten coupling nuts which secure flexible harness to conduit tee fitting. Place conduit in position in hull and attach clips. Insert wires in bulkhead terminal box, and connect them to terminal block with numbers matching wires on block. Insert sending unit harness behind fuel tank shield, and attach wire to sending unit on top of vertical fuel tank. Install left taillight connector plug in connector socket, and tighten connector nut. Test circuit. Tighten connector nut to tee on bulkhead. Tighten all connector nuts. Connect engine oil cooler lower tube to oil cooler. Install oil cooler shutter control rod. Install shut-off valve control rod. Install lower left engine shroud and seal. Install sending unit harness clips. Install bulkhead terminal box cover. Install engine (par. 52).

(11) ENGINE MAGNETO WIRING CONDUIT (figs. 80 and 43). If wires have been removed from conduit, install new wires (fig. 69). Place conduit in position in hull and install clips. Insert wires into elbow on bulkhead, and connect wires to magneto terminal block with numbers matching wires on block. Tighten conduit connector nut to elbow. Test circuit. Tighten all conduit connections. Connect engine oil cooler lower tube to cooler. Install shut-off valve control rod and oil cooler shutter control rod. Install lower engine shroud and seal. Install bulkhead terminal box. Install engine (par. 52).

12) FUEL TANK, TAILLIGHT, AND ENGINE COMPARTMENT HEATER WIRING CONDUIT (figs. 80 and 81). If wiring has been removed from conduit, install wiring (fig. 69) in conduit and flexible

harness. Place conduit in hull and attach clips. Insert wires into bulkhead terminal box through bulkhead tee, and connect them to terminal block with numbers matching wires on block. Attach connector nut to tee fitting. Insert sending unit harness behind fuel tank shield, and wire to sending unit on top of vertical fuel tank. Install right taillight connector plug in connector socket, and tighten connector nut. Insert wire in terminal box, and connect it to terminal. Tighten harness connector nut on terminal box. Test circuit. Install terminal box cover and bulkhead terminal box cover. Install shut-off valve control rod. Install lower right engine shroud and seal. Install sending unit harness clips. Install engine (par. 52).

(13) CRANKING MOTOR WIRING CONDUIT. If cable has been removed from conduit, insert cable in conduit. Place conduit in hull and attach clips. Insert front end of cable through elbow fitting into bulkhead terminal box and attach it to cranking motor solenoid switch. Install terminal box cover. Connect conduit connector nut to elbow. Install shut-off valve control rod. Install lower right engine shroud and seal. Install engine (par. 52).

98. INSTRUMENT PANEL.

a. Description (figs. 82, 83, 84, 85, and 86). The instrument panel is a shock-mounted metal box located on the sponson to the left of the driver. The cover of the box forms a panel which carries the instruments and gages.

b. Removal of Instrument Panel.

(1) REMOVE INSTRUMENT PANEL ASSEMBLY. Open battery master switch. Disconnect the wiring harnesses from the back of the instrument panel. Disconnect ground wire from panel. Disconnect tachometer and speedometer cables. Remove the screws securing panel to mounting brackets. Remove the panel.

(2) REMOVE PANEL COVER WITH INSTRUMENTS. Disconnect the conduits and cables from the back of the assembly. Remove the screws which hold the face of the panel on the box, and remove the panel with all instruments attached.

c. Replacement of Instruments (fig. 84). Remove the instrument panel (subpar. **b** above). Tag or otherwise identify wires to electrical instrument or gage that is to be replaced, so that the wires can be connected in the proper position on the replacement unit. Remove the screws or nuts which attach the unit to the assembly; in the case of switches, remove the lever from the switch, then remove the unit from the panel. Place the new unit in position, and install the attaching nuts or screws. Connect the wires in the proper position. Refer to wiring diagram (fig. 85) if wires are not identified or tagged. Install the instrument panel (subpar. **d** below). In the case

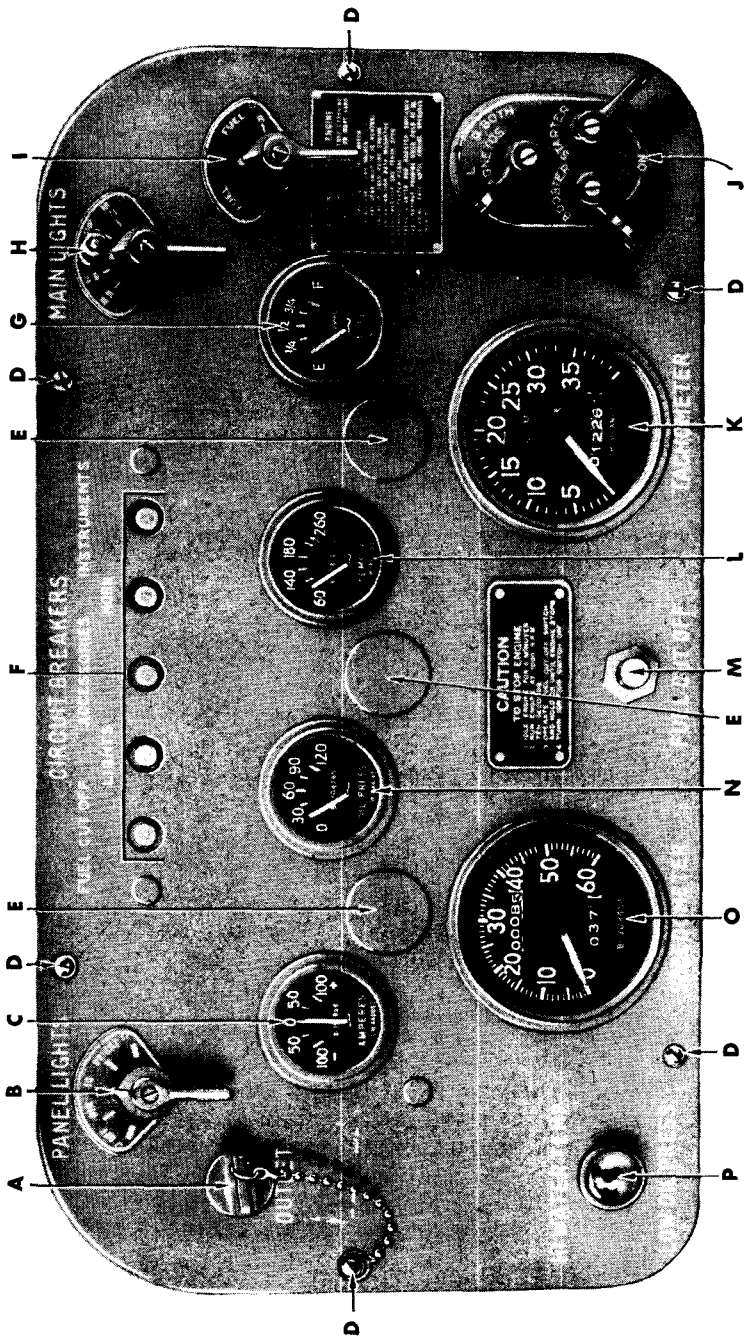


Figure 82 — Instrument Panel Assembly

A—UTILITY OUTLET SOCKET

B—PANEL LIGHT SWITCH—C102763

C—AMMETER—G104-05-00030

D—PANEL ATTACHING SCREW

E—PANEL LIGHT COVER

F—CIRCUIT BREAKERS

G—FUEL GAGE—B209888

H—MAIN LIGHT SWITCH

I—FUEL GAGE SELECTOR SWITCH—C102762

J—CRANKING MOTOR AND MAGNETO SWITCH—G104-05-04369

K—TACHOMETER

L—ENGINE OIL TEMPERATURE GAGE—B208797A

M—FUEL CUT-OFF SWITCH—A298391

N—OIL PRESSURE GAGE—B208795

O—SPEEDOMETER

P—LOW OIL PRESSURE WARNING LIGHT

RA PD 313314B

Legend for Figure 82

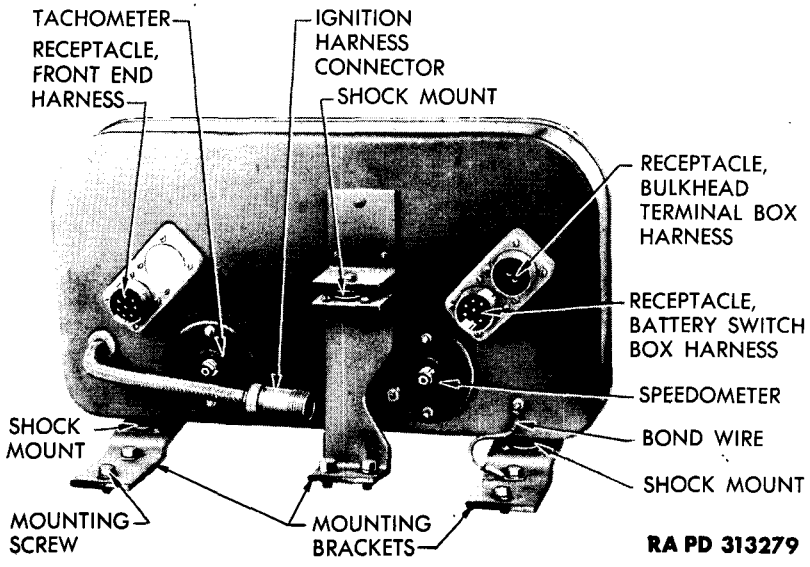


Figure 83 — Instrument Panel Removed

of the speedometer or tachometer, connect the cables. NOTE: *Voltmeters are no longer being installed and voltmeters that become inoperative on older vehicles in the field will not be replaced. Disconnect inoperative voltmeter by detaching the wiring at the voltmeter and taping the ends of the disconnected wire. Leave the voltmeter mounted in the instrument panel.*

d. Installation of Instrument Panel (figs. 82, 83, 84, 85, and 86).

(1) INSTALL INSTRUMENT PANEL ASSEMBLY. Place the instrument panel assembly on the sponson, and connect all the wiring harnesses. CAUTION: *Be sure that the conduit plugs index properly where making connections, to avoid damage to the plugs and crossing of the circuits.* Connect speedometer and tachometer cables. Position the panel assembly on the sponson, and install the shock mounting cap screws. Attach the radio interference suppression ground wire to the terminal post on the back of the panel.

(2) INSTALL INSTRUMENT PANEL COVER AND INSTRUMENTS. Place the cover and instruments assembly into the panel box with the gaskets (A347592B) around the cover and receptacles in place. Install the screws which hold the cover on the box. Properly index the wiring harness plugs, and connect the wiring harnesses and cables. Attach the radio interference ground wire to the terminal post on the back of the instrument panel.

ELECTRICAL SYSTEM

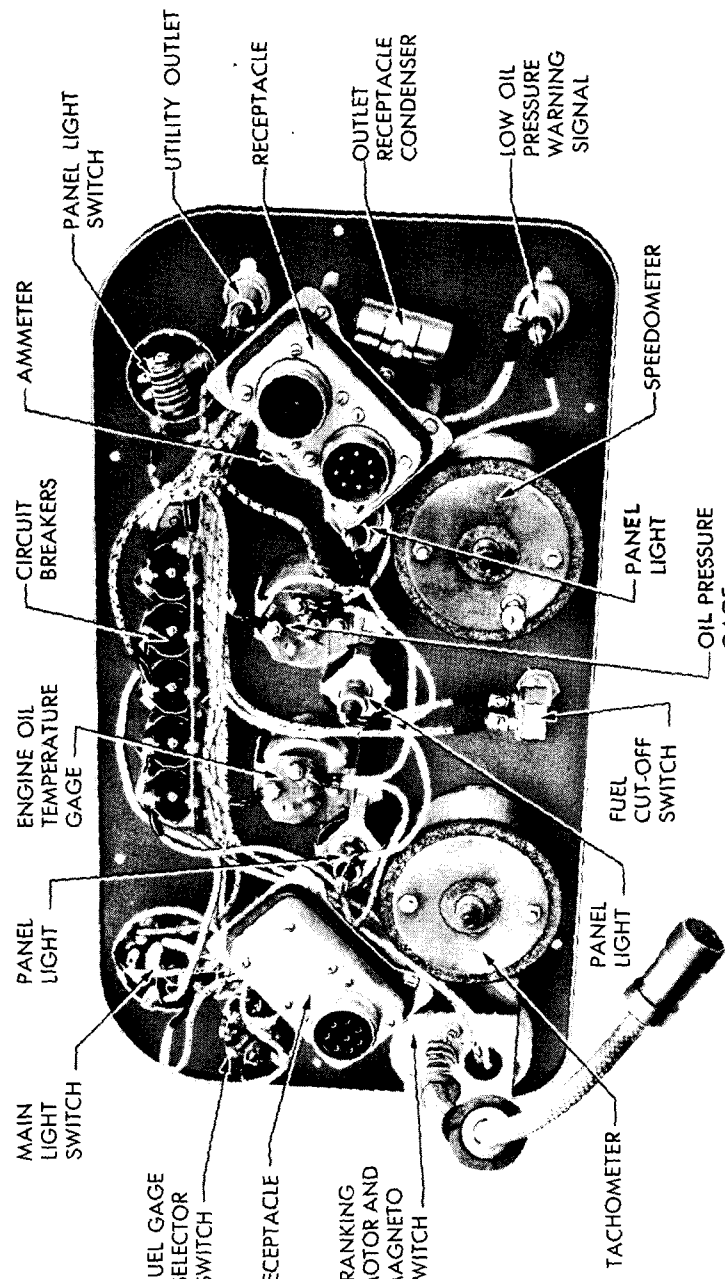
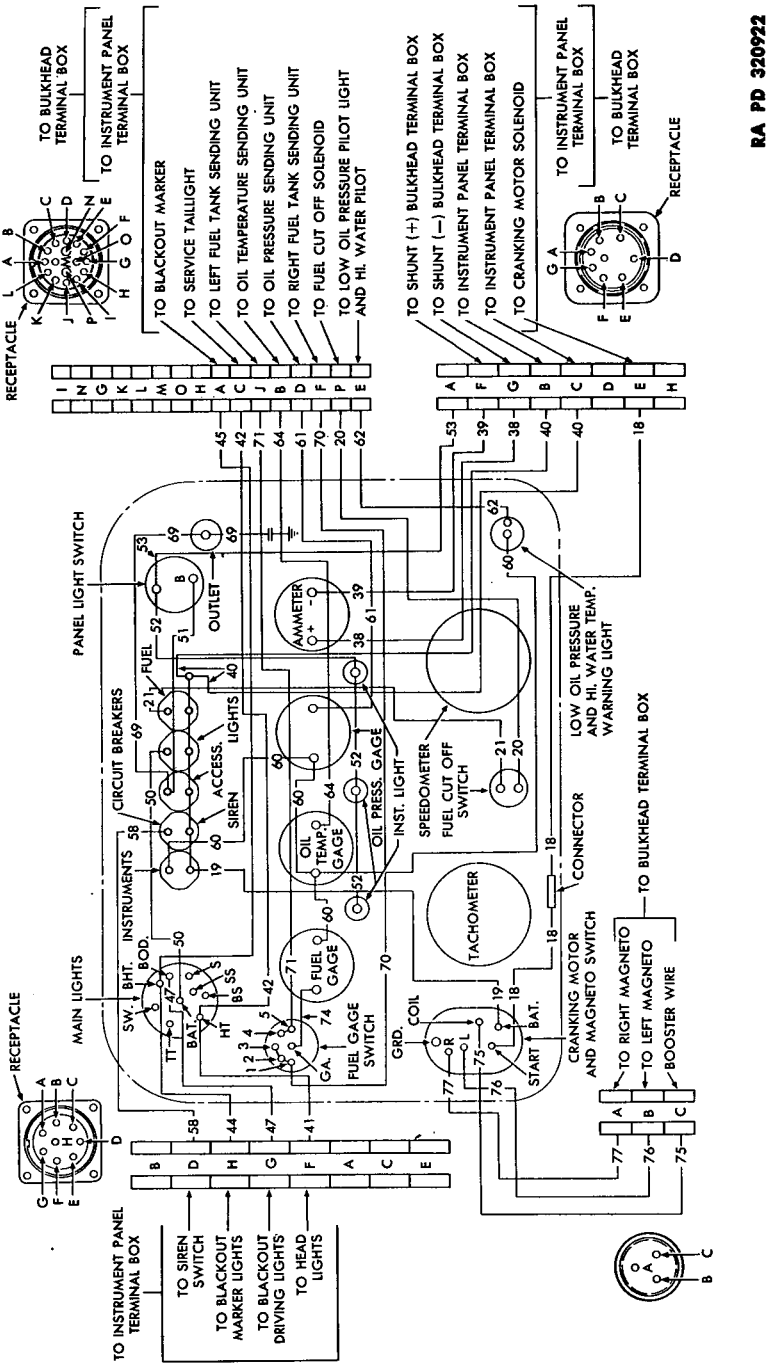


Figure 84 — Back of Instrument Panel

CARRIAGE, MOTOR, 105-MM HOWITZER, M7



RA PD 320922

Figure 85 — Instrument Panel Wiring Diagram

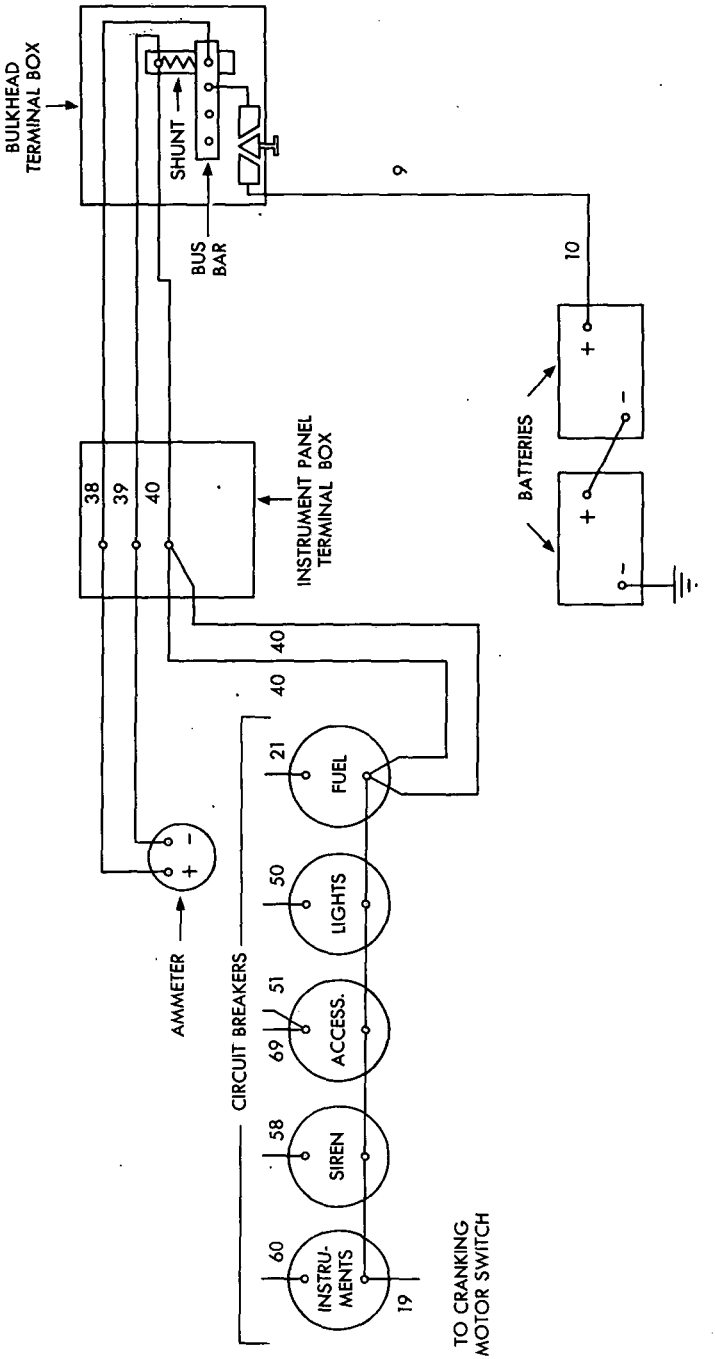


Figure 86 — Power Supply to Instrument Panel

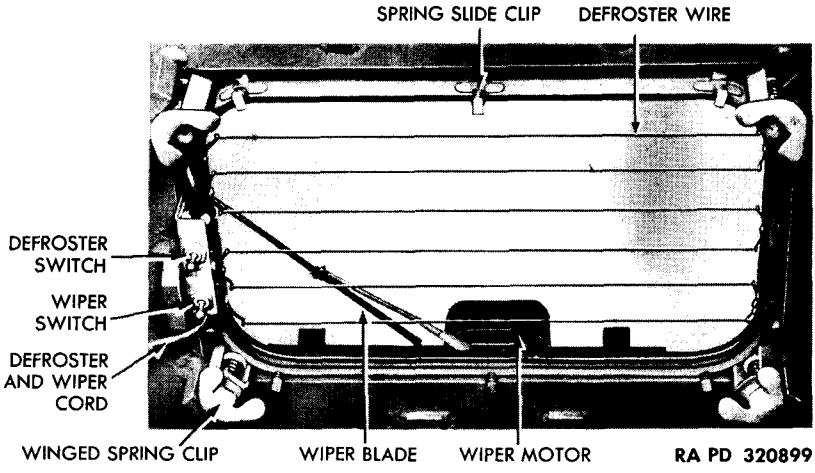


Figure 87 — Windshield Wiper and Defroster

99. WINDSHIELD WIPER AND DEFROSTER.

a. Description (figs. 87 and 88).

(1) WINDSHIELD. The windshield is an accessory which when not in use is stowed in the left stowage compartment. It consists of metal-rimmed glass made to fit the driver's compartment door opening. The windshield is mounted on the outside of the hull and is held in place by four clips. The inside facing of the frame is constructed of ribbed rubber to make a watertight and weatherproof fitting between the hull and the windshield. The windshield must be stowed when the driver's compartment door is closed.

(2) WINDSHIELD WIPER. The windshield wiper is electrically controlled and operated. It is mounted on a metal bracket which extends below the windshield.

(3) DEFROSTER. The defroster is a metal-framed glass similar to, but somewhat smaller than the windshield. It is secured to the inside of the windshield by means of six spring clips which hold the defroster securely about 1 inch from the windshield. An electric heating element, consisting of six parallel, horizontally positioned heating wires, heats the air space between the windshield and the defroster. A toggle switch mounted on the side of the defroster controls the current to heat the element.

b. Removal (fig. 87).

(1) WINDSHIELD.

(a) Disconnect wiper electric wire connector.

(b) Disconnect defroster electric wire connector.

ELECTRICAL SYSTEM

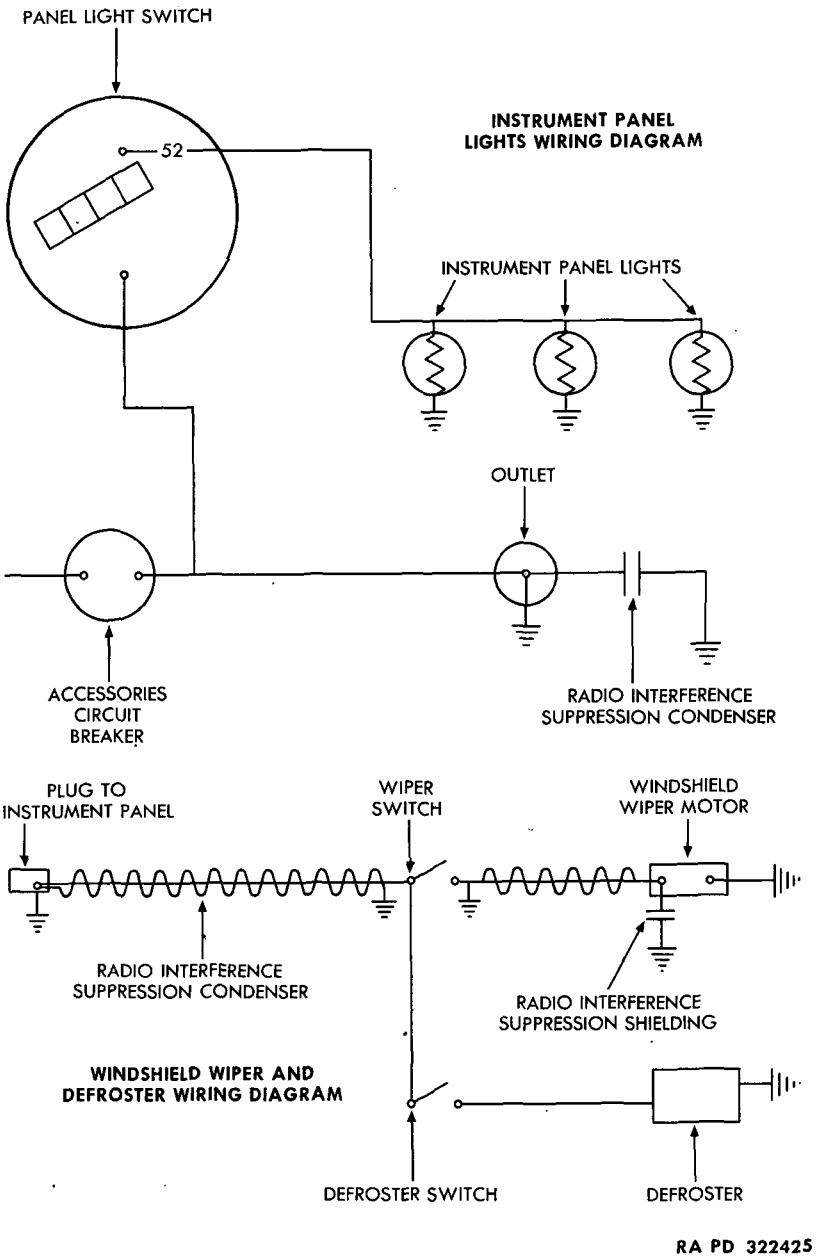


Figure 88 — Instrument Panel Lights and Windshield Wiring Diagram

(c) Release spring tension on four spring catches, one located in each corner on the inside of the windshield.

(d) Support the windshield with one hand and push forward with other hand until windshield and clips clear hull.

(2) WINDSHIELD WIPER. Remove two cap screws, nuts, and lock washers which secure windshield wiper and condenser to mounting bracket. Remove two nuts, washers, and lock washers which secure wire leads and condenser to windshield wiper terminals. Remove wires and condenser.

(3) DEFROSTER. Release six spring catches which secure defroster to windshield. Support the defroster with hand until catches are released, and then remove defroster.

c. Installation (fig. 87).

(1) REPLACEMENT. A defective switch or wiring on the defroster requires replacement of the entire defroster unit. Defective wiring on the windshield (for windshield wiper) requires replacement of the entire windshield unit.

(2) WINDSHIELD WIPER. Position two lead wires and condenser on windshield wiper terminals and secure with two washers, lock washers, and nuts. Position windshield wiper on bracket (with wiper toward outside) and secure with two bolts, lock washers, and nuts.

(3) WINDSHIELD. Position windshield on outside of hull, and secure four spring clips on inside of hull.

(4) DEFROSTER. Position defroster on inside of windshield, and secure with six spring clips. The defroster may be removed or replaced with windshield on or off the vehicle.

100. HEADLIGHTS AND MARKER LIGHTS.

a. Description and Data.

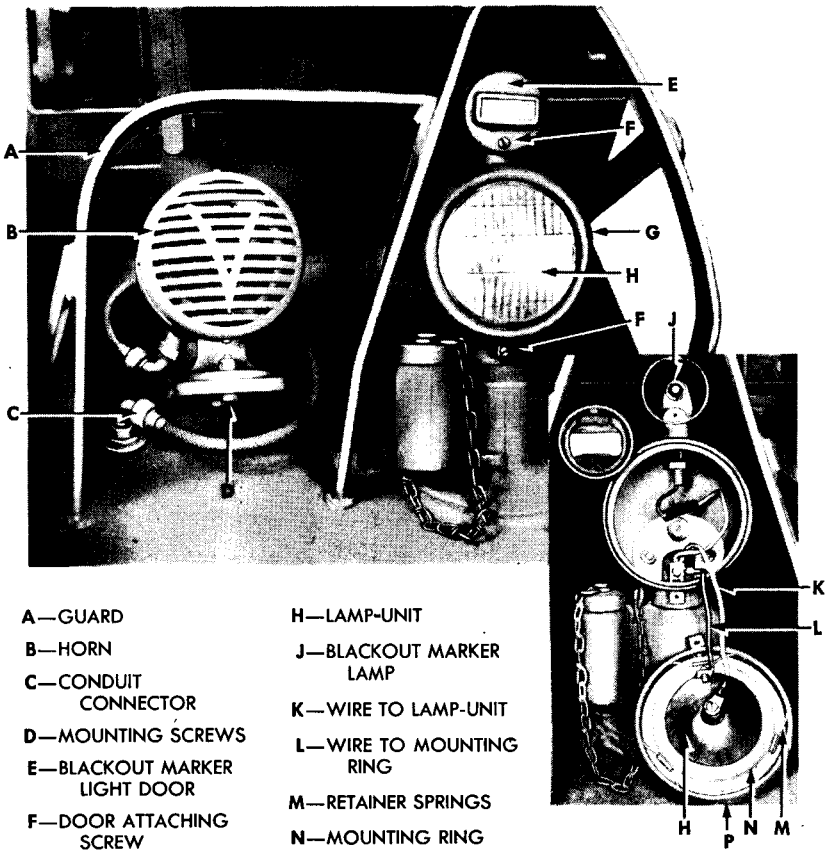
(1) DESCRIPTION (fig. 89). The headlights consist of a lamp-unit housed in the body of the light and a blackout marker light mounted on top of the headlight body. The headlights are carried in the right sponson box until ready for use. The lights are installed in sockets through the front of the hull. The socket is weather-sealed by a plug which is chained to the guard and carried in a socket on the side of the guards when the headlights are installed.

(2) DATA.

Manufacturer	Guide Lamp Div.
Type	D59636A

b. Removal and Installation of Headlights. Unscrew the locking pin from the headlight socket inside the hull (on the outside of hull, right side), and lift lamp out of the guard. To install, place the headlight assembly in the socket and tighten the locking pin.

ELECTRICAL SYSTEM



A—GUARD
B—HORN
C—CONDUIT CONNECTOR
D—MOUNTING SCREWS
E—BLACKOUT MARKER LIGHT DOOR
F—DOOR ATTACHING SCREW
G—HEADLIGHT DOOR
H—LAMP-UNIT
J—BLACKOUT MARKER LAMP
K—WIRE TO LAMP-UNIT
L—WIRE TO MOUNTING RING
M—RETAINER SPRINGS
N—MOUNTING RING
P—SLOT

RA PD 320935

Figure 89 — Headlight and Blackout Marker Light

c. Replacement of Headlight Lamp-unit (fig. 89). Remove the attaching screw at the base of the headlight door. Pull the door out at the base and lift up. Disconnect the wire at the back of the lamp-unit. Disconnect ground wire. Unhook the retainer springs on the back of the lamp-unit and remove the unit. To install, place the lamp-unit in the door, with the top mark on the lens up, and secure with the mounting ring and retainer springs. Make sure lug on lamp fits in slot on mounting ring. Attach the wire to the terminal on the back of the lamp-unit and ground wire to mounting ring. Install the headlight door.

d. Replacement of Blackout Marker Lamp (fig. 89). Remove the attaching screw at the base of the door, and lift off the door. Press in on the lamp, turn counterclockwise, and pull out. To install,

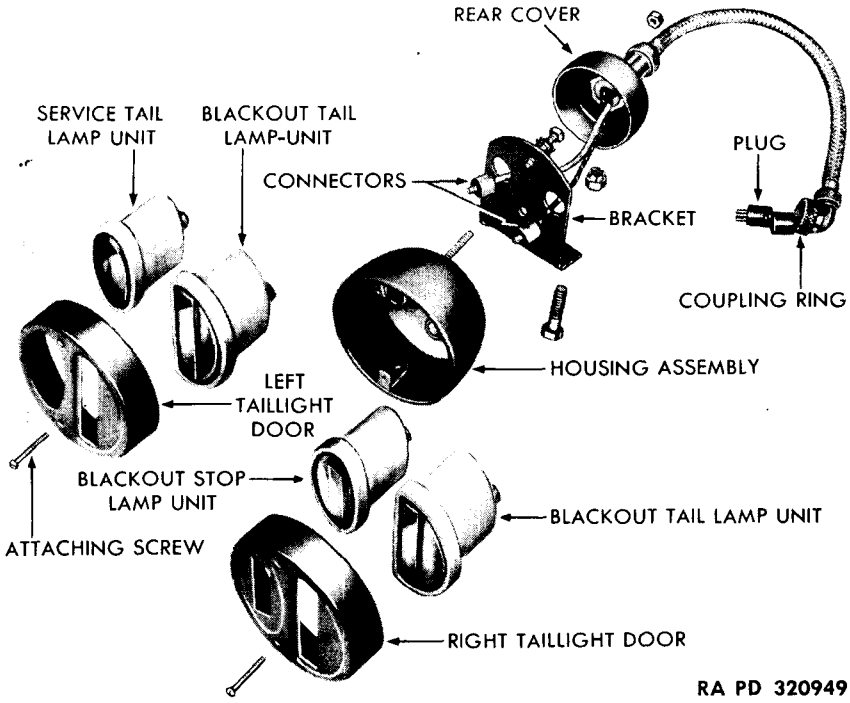


Figure 90 — Taillights

insert the lamp into the socket, press in, and turn clockwise. Hook the lip on the top of the door into the slot in the light body, press the door into position, and install the mounting screw.

101. TAILLIGHTS.

a. Description (fig. 90). Two taillights are located on the rear corners of the vehicle. The left taillight contains a combination service tail and stop light lamp-unit in the upper part of the light (stop light section is not used on late models) and a blackout taillight lamp-unit in the lower part of the light. The right taillight contains a blackout stop light lamp-unit in the upper part (not used on late models) and a blackout taillight lamp-unit in the lower part.

b. Removal of Lamp-units (fig. 90). Remove the two retaining screws and lift off taillight door. Pull the lamp-unit out of its socket, install the new lamp-unit, and install the door.

c. Removal of Taillight Assembly. Unscrew the conduit coupling ring, and disconnect the plug from the hull socket. Remove two lock nuts which hold the taillight rear cover to the taillight housing. Remove the two connectors from the light sockets. Tag the wires

for correct assembly. Remove two nuts from taillight mounting screws, and pull light from bracket.

d. Installation of Taillight Assembly. Place taillight housing on bracket, and install toothed lock washers and mounting screw nuts. Insert wires and connectors in taillight housing sockets with wire No. 45 in the upper socket. Place rear cover in position, and install lock nuts. Connect the plug and socket, and tighten the conduit coupling ring.

e. Stop Light Switches. On early model vehicles, the service and blackout stop lights are controlled by switches connected with the steering hand levers. No stop signaling will be seen until both levers are pulled, indicating a slowing or full stop. Stop lights are not used on late models.

102. BLACKOUT DRIVING LIGHT.

a. Description and Data.

(1) DESCRIPTION. The blackout driving light is equipped with a shielded 6-volt lamp-unit to limit the volume of light for use in blackout conditions. The left headlight socket is wired through a resistor to accommodate the use of the blackout driving light.

(2) DATA.

Manufacture ..... Guide Lamp Div.
Type D59771A

b. Removal and Installation. Refer to taillight (par. 101 c and d).

c. Replacement of Lamp-unit. Refer to replacement of lamp-unit in paragraph 100 c.

103. HORN.

a. Description and Data.

(1) DESCRIPTION. The horn or siren is bracket-mounted under a guard near the left headlight and is connected by flexible conduit through the front of the hull to a push-button switch mounted on the right steering brake lever just below the rubber grip. The horn operates on 24 volts, and the switch is supplied with current from the instrument panel through the front end wiring harness, when the battery master switch is closed.

(2) DATA.

Horn Switch:

Manufacturer ..... Micro Switch Corp.
Model A384601

b. Replacement of Horn (fig. 89). Disconnect the flexible conduit at the fitting on the hull, pull the connector plug apart, and remove the two horn mounting bolts. Position the new unit on the hull under the guard, and install the mounting bolts. Connect the flexible conduit from horn to hull fitting. Tighten conduit connector.

c. Replacement of Horn Switch. Remove the mounting bolts which hold the switch to the steering brake lever. Unscrew the conduit coupling ring from the switch assembly, and remove the cover from the switch. Disconnect the wires from the switch, and remove the switch. To install, remove the cover from the new switch and remove the connector screws. Connect the wires to the switch terminal, and install the switch cover. Attach the conduit to the switch, and mount the switch on the steering brake lever.

Section XXII

INTAKE AND EXHAUST SYSTEMS

104. DESCRIPTION.

a. Exhaust Pipes (fig. 91). On later models, two horizontally mounted exhaust pipes are installed under the engine compartment top plate and connected with the elbows at the top of the exhaust manifolds. Exhaust gases are expelled through two tail pipes into an exhaust deflector at the rear center of the hull. On early models, two mufflers are used instead of exhaust pipes.

b. Air Intake Horns. Two horizontally mounted air intake tubes are installed under the engine compartment top plate, one at the right side and one at the left side of the engine compartment. The fronts of the air intake tubes extend through the upper engine shroud and are fitted with air intake horns which act as air scoops.

105. EXHAUST PIPES (LATE MODELS).

a. Description (fig. 91). Late model vehicles have two exhaust pipes and tail pipes. Some late models have a bracket across the tail pipes which is attached to the rear top plate over the engine compartment.

b. Removal. Remove engine compartment rear top plate (par. 51 b). Remove cap screws and toothed lock washers which secure tail pipes to rear plate of hull. Remove clamp bolt nuts and remove clamps at front and rear of exhaust pipes. Telescope the pipe sections and lift out exhaust pipes.

c. Installation. Place the exhaust pipe in position and pull it out to full length between rear plate of hull and manifold elbows.

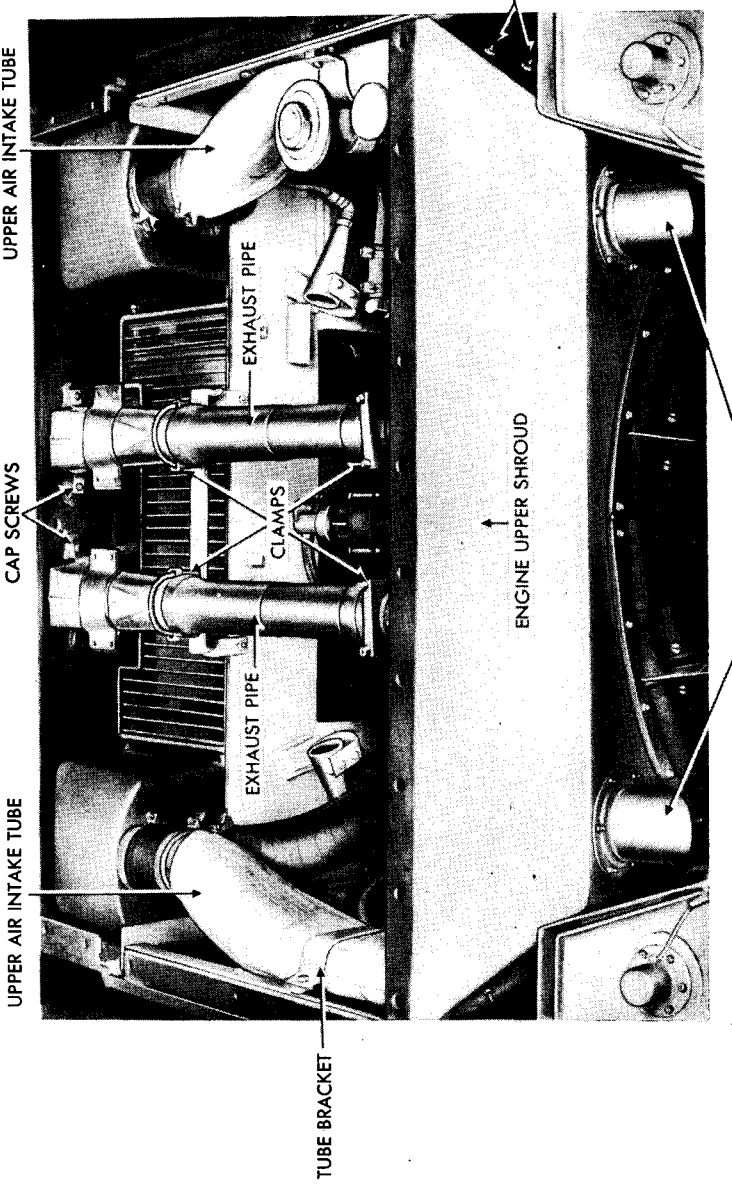


Figure 91 — Exhaust Pipes and Engine Upper Shroud

Fit front end over elbow. Install cap screws and toothed lock washers which secure tail pipe to hull plate. Place U-clamps at front and rear ends, and install clamp bolts and nuts. Place rear bracket (if used) across tail pipes, and install clamp bolts. Install engine compartment rear top plate (par. 52 **p**).

106. EXHAUST PIPES AND MUFFLERS (EARLY MODELS).

a. Description. Early model vehicles have two mufflers instead of exhaust pipes. Tail pipes are attached to the rear ends of the mufflers.

b. Removal. Remove engine compartment rear top plate (par. 51 **b**). Remove nuts from U-clamp that secure each muffler to manifold, and remove U-clamps. Remove straps. Remove mufflers by pulling them to rear.

c. Installation. Position muffler bracket and secure it to engine support beam with two bolts. Install bolts which secure muffler bracket supports to bracket. Place tail pipe and muffler assemblies in position and install straps which hold muffler to muffler brackets. Install lock washers, nuts, and U-clamps which secure each muffler to manifold. Install engine compartment rear top plate (par. 52 **p**).

107. AIR INTAKE HORNS.

a. Description. The air intake horns are installed on the front end of the upper air intake tubes which carry air back to the air cleaners. The front end of the horns are cut off on a bias, and the extended edge must always be on top when the horns are in place. The upper air intake tubes are covered with a heat-insulating material.

b. Removal. Remove engine compartment rear top plate (par. 51 **b**). Loosen intake pipe clamps at rear ends of intake pipes. Remove tube bracket cap screws which attach intake pipes to fuel tank shields. Work intake pipes off air cleaner hoses, and pull them out from the rear. On late models, loosen clamps securing air intake horns and pull off horns from air intake tubes.

c. Installation. Clean out inside of air intake tubes and horns. Place air intake horns on front end of each air intake tube. Tighten tube clamps, making sure that air intake horns are rotated so that extended edge is on top. Place tubes in hull, with air intake horns inserted in engine compartment upper shroud. Insert rear ends of tubes in air cleaner hoses. Install clamps. Install intake pipe brackets, and install cap screws which secure the brackets to fuel tank shields. Install engine compartment rear top plate (par. 52 **p**).

Section XXIII

CLUTCH

108. DESCRIPTION AND DATA.

a. Description.

(1) The clutch is a multiple-disk type mounted inside the flywheel. It consists of two clutch-driven disks (one outer and one inner), one driving plate, one pressure plate, and six springs assembled to the flywheel ring.

(2) The openings in the flywheel ring and flywheel allow the passage of air for ventilation. Separator pins provide a means of separating the driven disks and driving plate. An annular release bearing is used.

b. Data.

Manufacturer	Rockford Drilling Machine Co.
Model (ordnance No.)	D78123
Type	Multiple-disk, dry clutch

109. CLUTCH.

a. Removal.

(1) REMOVE ENGINE (par. 51).

(2) REMOVE UNIVERSAL JOINT COMPANION FLANGE AND NUT. Pull the cotter pin and remove the nut, washer, and flange.

(3) REMOVE FLYWHEEL RING TO FLYWHEEL BOLT NUTS (fig. 93). Loosen the lock nuts and screw out the three driving plate separator studs three turns. Unscrew the flywheel bolt nuts around the outer edge of flywheel ring. Punch-mark the flywheel and the flywheel ring at one point on each, for identification in assembling parts.

(4) REMOVE FLYWHEEL RING AND PRESSURE PLATE ASSEMBLY (fig. 92). Install three 3/8- by 4-inch—16 full thread (National coarse) jack screws in the three holes provided for this purpose, and tighten them alternately until the flywheel ring is forced away from the flywheel. Tap the end of the spindle, and lift off the flywheel ring.

(5) REMOVE PLATES AND SPINDLE (figs. 94 and 95). Lift off the outer driven disk, the driving plate, and the inner driven disk. Pull off the spindle.

b. Installation.

(1) INSTALL SEPARATOR PINS (1, fig. 94). Insert the small end of the three driven plate separator pins which enter the small end of the pin in the hole in the flywheel. These pins must be a free fit,

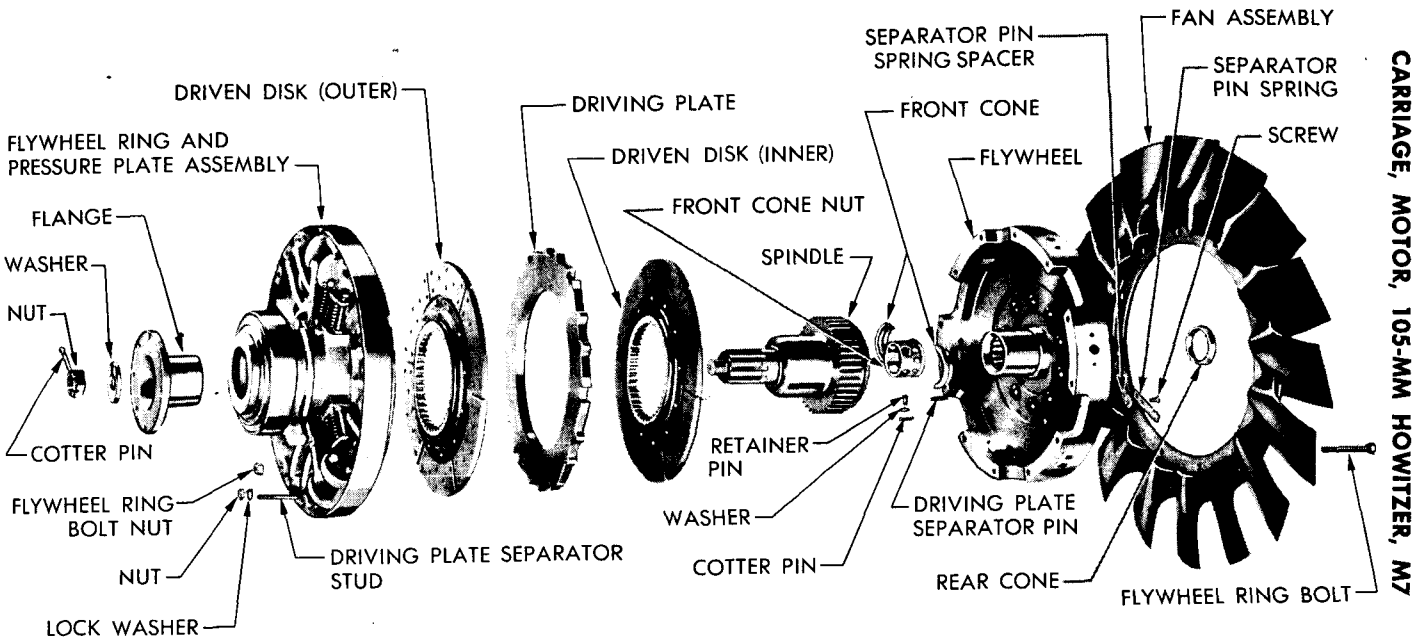


Figure 92 — Clutch and Fan Disassembled

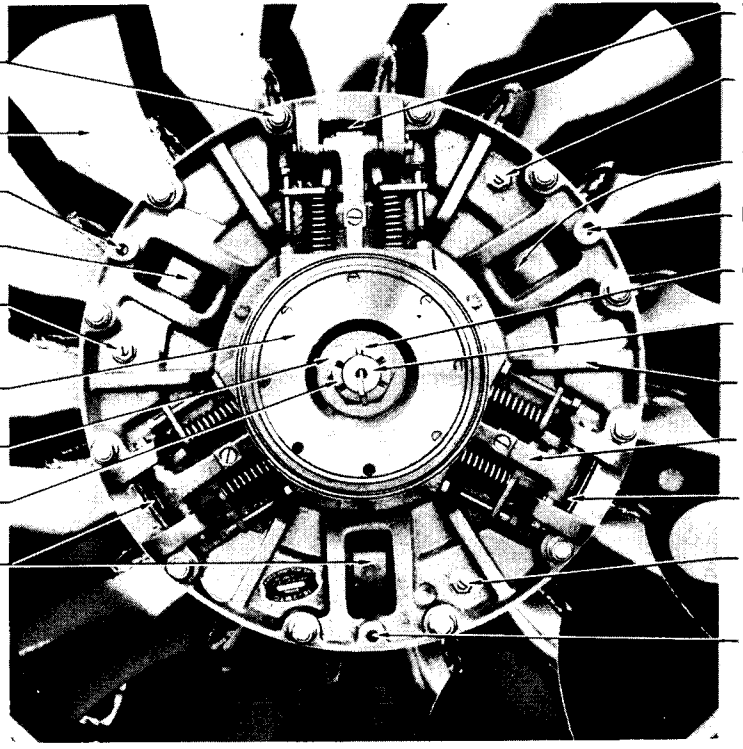
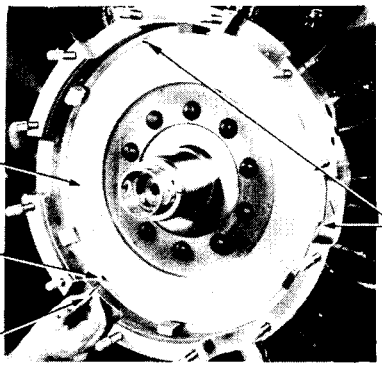
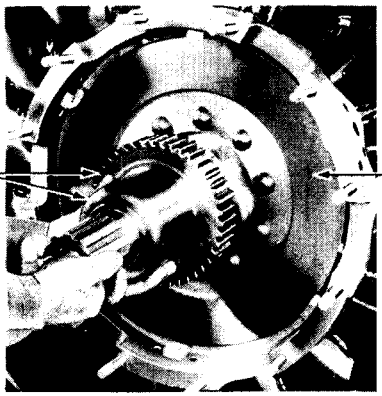


Figure 93 — Clutch and Fan Assembled

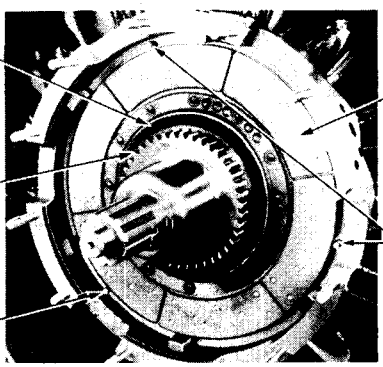
CARRIAGE, MOTOR, 105-MM HOWITZER, M7



1. INSTALLING DRIVING PLATE SEPARATOR PINS



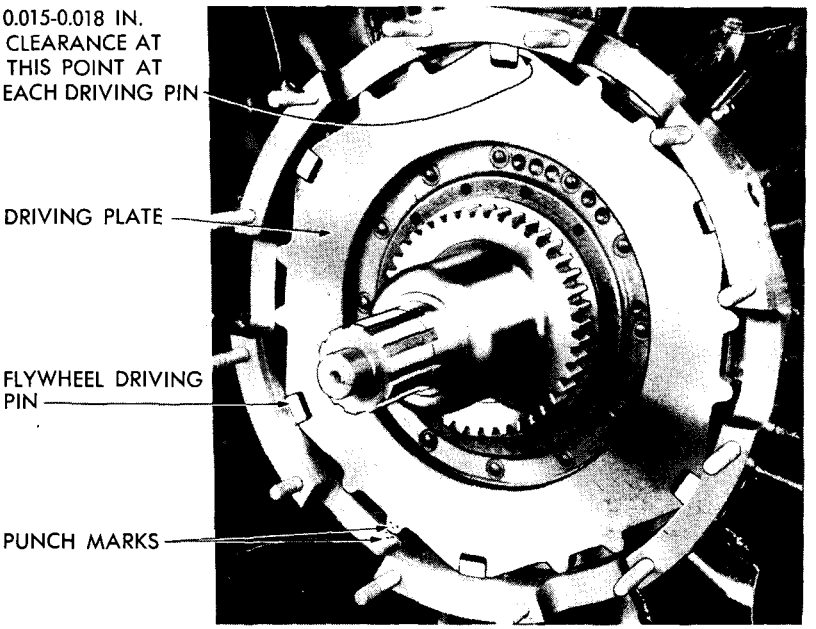
2. INSTALLING SPINDLE



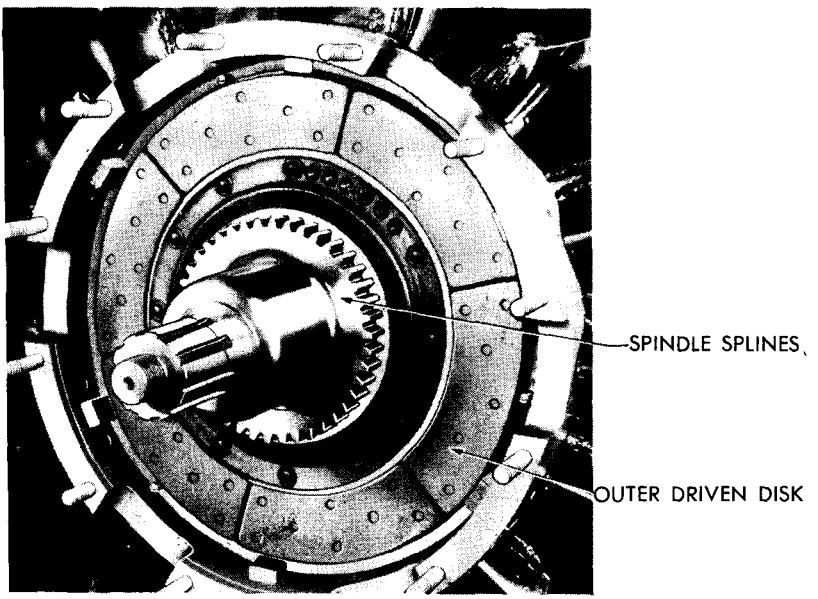
3. INNER DRIVEN DISK IN POSITION

RA PD 53594

Figure 94 — Installing Inner Driven Disk



1. DRIVING PLATE IN POSITION



2. OUTER DRIVEN DISK IN POSITION

RA PD 53595

Figure 95 — Installing Drive Plate and Outer Driven Disk

and pins must contact the lead spring on the rear side of flywheel.

(2) INSTALL SPINDLE ON FLYWHEEL HUB (2, fig. 94). Wash the spindle thoroughly in dry-cleaning solvent, and clean all foreign matter from the spindle bearing inside the opening. Apply compressed air to the opening of the spindle, and remove all traces of dry-cleaning solvent. Wipe spindle dry, and pack with grease (par. 21), then fill cavity in the spindle flush with inside diameter of the bearing. Slide the spindle on the spindle and hub.

(3) INSTALL INNER CLUTCH DRIVEN DISK IN FLYWHEEL (3, fig. 94). Wipe all surfaces clean and make sure the splines in the hub are free of burs. Be sure the three separator pins are in place in the flywheel. Position disk with body of hub section away from flywheel on the splines of the spindle, and push the disk into flywheel.

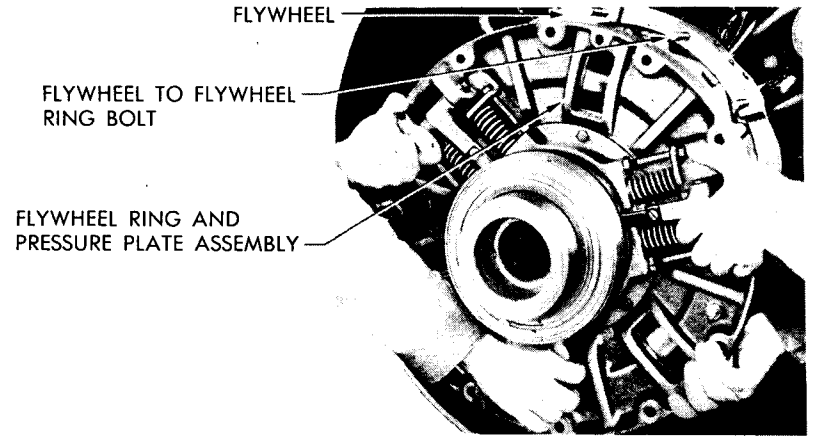
(4) INSTALL DRIVING PLATE IN FLYWHEEL (1, fig. 95). Wipe all surfaces clean and make sure all burs are removed. Position the driving plate in the flywheel with the three punch marks on one of the plate projections alined with the marks at one of the flywheel openings, if the original plate is used. Aline the six driving pins with the slots in the plate. Check the clearance of the slots at the driving pins with a feeler gage. The correct clearance is 0.015 inch, minimum. *Do not install the driving plate if the clearance is less than 0.015 inch.* Press the plate against the separator pins, and release the pressure to see if the pins are working correctly.

(5) INSTALL OUTER DRIVEN DISK (2, fig. 95). Wipe all surfaces clean and make sure the splines in the hub are free from burs. Position disk on the splines of the spindle with body of hub section away from flywheel. Be sure the disk slides freely on the splines of the spindle.

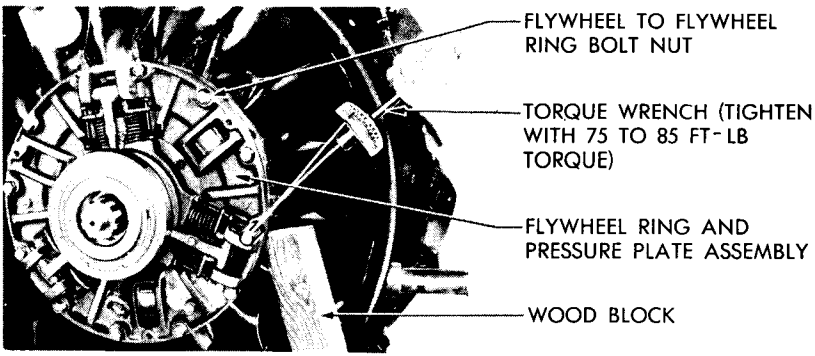
(6) INSTALL FLYWHEEL RING AND PRESSURE PLATE ASSEMBLY (1, fig. 96). Wipe all surfaces clean. Pack the space between the ball bearing and the oil retainers in the hub with grease (par. 21). Lift the assembly into position on the end of the spindle, aline the punch marks on the flywheel and flywheel ring, and slide the assembly onto the bolts.

(7) INSTALL FLYWHEEL BOLT NUTS. Install the nuts on the bolts, and tighten nuts alternately until the assembly is pulled evenly against the flywheel to eliminate binding. Tighten nuts with 75 to 85 foot-pounds of torque (2, fig. 96). Screw the drive plate separator studs in until they touch the plate, then loosen them one complete turn to give $\frac{1}{16}$-inch clearance between tip of stud and intermediate driving plate, and tighten the lock nuts (3, fig. 96).

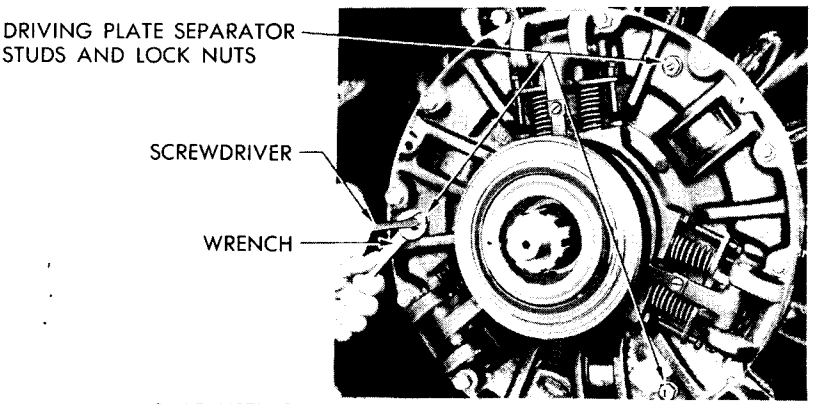
(8) TEST CLUTCH FOR RELEASE (fig. 97). Place the end of a bar against the front flange of the clutch release sleeve. Rest the bar on a wood block on the outer edge of the flywheel ring. Press the



1. INSTALLING FLYWHEEL RING AND PRESSURE PLATE ASSEMBLY



2. TIGHTENING FLYWHEEL TO FLYWHEEL RING BOLT NUTS



3. ADJUSTING DRIVING PLATE SEPARATOR STUDS

RA PD 320028

Figure 96 — Installing Flywheel Ring and Pressure Plate Assembly

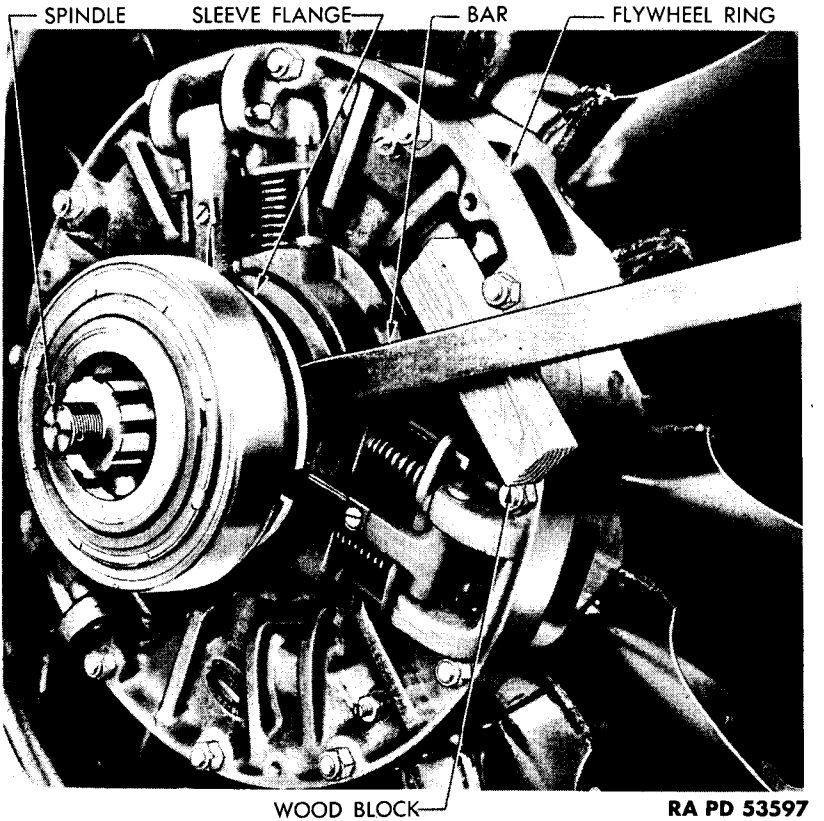


Figure 97 — Testing Clutch For Release

bar against wood, and move the release sleeve ½ inch away from the clutch. With the sleeve in this position, the spindle should turn freely by hand.

(9) INSTALL UNIVERSAL JOINT FLANGE. Aline punch marks on the flange and the end of the spindle, and slide the flange onto the spindle. Place the flat washer on the spindle, screw the nut on, and tighten to 240 to 280 foot-pounds torque (approximately 150 pounds pressure on the end of a bar 2 feet long); install a cotter pin.

(10) INSTALL ENGINE (par. 52).

(11) RECORD UNIT REPLACEMENT ON W.D., A.G.O. FORM NO. 478. If a new or rebuilt clutch assembly has been installed, make the proper entry on "MWO and Major Assembly Replacement Record." See paragraph 2 a (3).

c. Cleaning. Dirt or dust in the clutch is usually indicated by a gradual reduction in full clutch pedal travel or full clutch release,

due to the blocking action of the dirt in the clutch. At the indication of such a condition, work the dust out of the clutch. Do not try to force the clutch pedal down as this will only pack the dirt more solidly and bend or deflect the clutch linkage system until the pedal free play adjustment will require resetting. With the engine at idling speed and the transmission in neutral, work the clutch pedal up and down rapidly, being careful not to force the clutch past the blocked position on the down stroke. Repeat this procedure until full pedal travel is restored. Clean the clutch with compressed air regularly if possible. Working the pedal and using compressed air may not effectively remove an accumulation of mud. In this case a steam jet may be used. If a steam jet is used, dry the clutch with compressed air and drive the vehicle to warm the clutch and remove any remaining moisture. Do not use steam to blow out sand and dust. If dirt is trapped behind the three-plate separator actuating springs on the back face of the flywheel, the clutch must be removed, disassembled, and cleaned.

110. CLUTCH PILOT BEARING.

a. Removal.

(1) REMOVE CLUTCH SPINDLE (par. 109 a (1) through (5)).

(2) REMOVE PILOT BEARING. Remove the retainer and the pilot bearing from the spindle.

b. Installation.

(1) INSTALL PILOT BEARING. Coat the pilot bearing with oil, and install the bearing and retainer in the spindle with a drift (41-D-1540-150).

(2) INSTALL CLUTCH SPINDLE (par. 109 b (2) through (11)).

111. CLUTCH RELEASE BEARING.

a. Removal.

(1) REMOVE ENGINE (par. 51).

(2) REMOVE UNIVERSAL JOINT COMPANION FLANGE. Pull the cotter pin, and remove the nut and washer from the end of the clutch spindle. Pull off the companion flange.

(3) REMOVE RELEASE BEARING. Remove the snap ring, lock ring, retainer, and seal from the release sleeve body; pull the bearing off the sleeve body.

b. Installation.

(1) INSTALL RELEASE BEARING. Press the bearing in place and install the seal, retainer, lock ring, snap ring.

(2) INSTALL UNIVERSAL JOINT COMPANION FLANGE. Press the flange into place and install the washer, nut, and cotter pin.

(3) INSTALL ENGINE (par. 52).

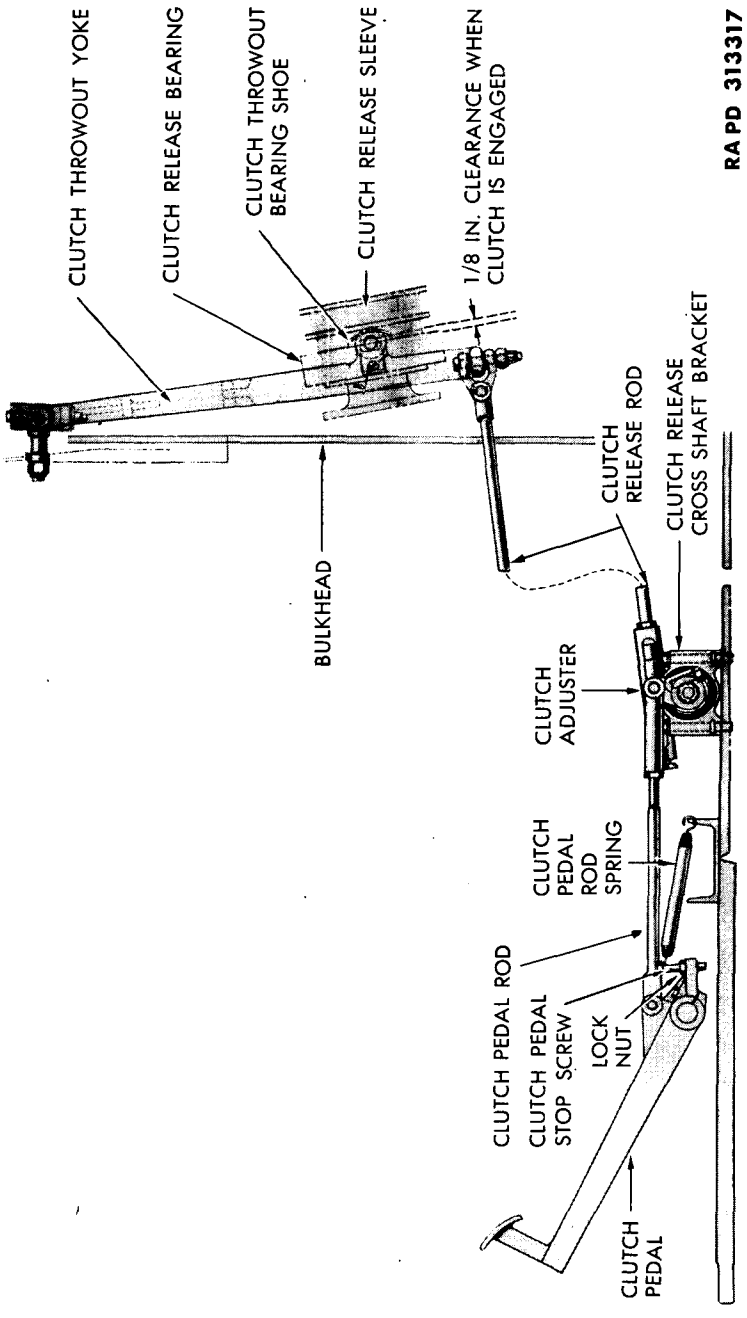


Figure 98 — Clutch Controls — Side View

CLUTCH

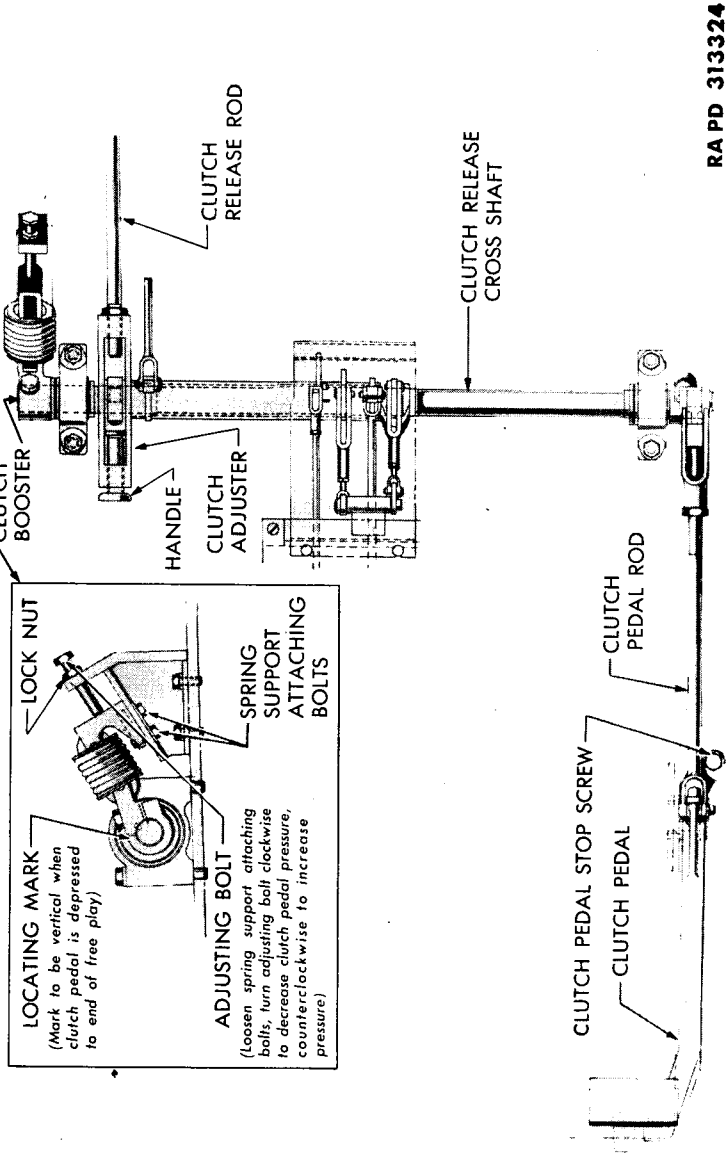
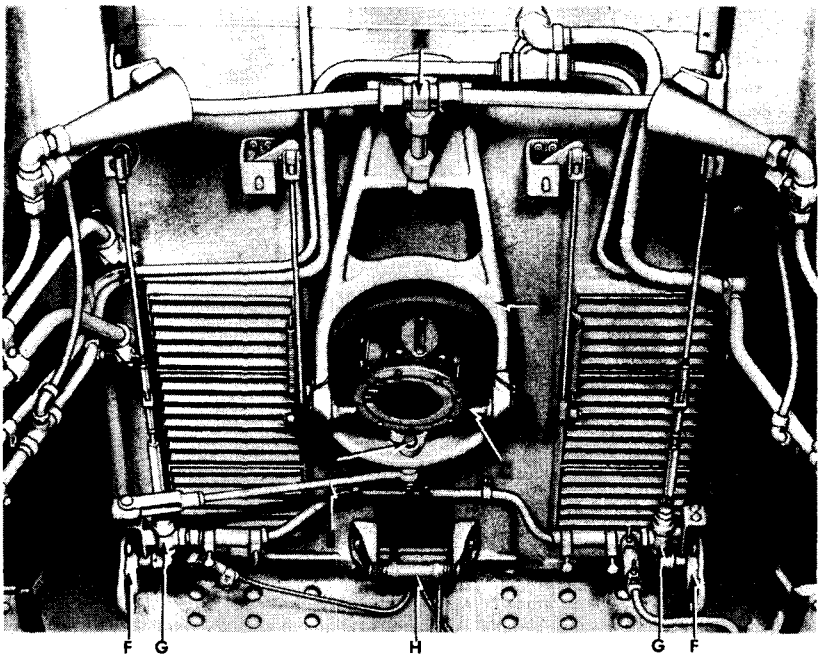


Figure 99 — Clutch Controls — Top View



A—FIRE EXTINGUISHER LINE
B—THROW-OUT YOKE
C—THROW-OUT BEARING SHOE
D—RELEASE ROD CLEVIS PIN
E—CLUTCH THROW-OUT BRACKET TIE ROD
F—FUEL FILTER
G—FUEL SHUT-OFF VALVE
H—ACCELERATOR SHAFT LEVER
RA PD 320976

Figure 100 — Clutch Throw-out Yoke — Engine Removed

112. CLUTCH RELEASE LINKAGE (figs. 98 and 99).

a. Description. To assure full spring load on the clutch driving plate and driven disks, it is necessary that the clutch pedal have free travel at all times. This free travel should be approximately 1¾ inches, measured at the clutch pedal pad. As the clutch facings wear, the amount of free travel is reduced. If the clutch facings wear to a point where no free travel of the clutch pedal is present, the clutch will be held partly disengaged, resulting in rapid clutch failure. An adjuster is provided at the front end of the clutch release rod. A booster is also attached to the right end of the clutch control cross shaft outside the propeller shaft housing to assist the driver in disengaging the clutch.

b. Adjustment. Turn the handle at the front end of the clutch adjuster counterclockwise to increase the clearance between the shoes and the bearing, and clockwise to decrease the clearance. The clearance between the shoes and the face of the clutch release bearing must be ⅛ inch. A ratchet arrangement in the adjuster will lock the

handle with the shoes adjusted to ⅛-inch clearance. The clutch pedal free travel will then be approximately 1¾ inches if the length of the clutch pedal rod has not been changed.

113. CLUTCH THROW-OUT BEARING SHOES.

a. Removal.

(1) REMOVE FIRE EXTINGUISHER TUBES. Remove air intake shutter and fire extinguisher tubes.

(2) REMOVE ENGINE COMPARTMENT INSPECTION PLATE. Remove the cap screws which hold plate to floor and remove plate.

(3) REMOVE RELEASE ROD CLEVIS PIN (fig. 100). Reach up through inspection hole in engine compartment floor and pull out cotter pin in release rod clevis pin, then pull out clevis pin.

(4) REMOVE TIE ROD CLEVIS PIN (fig. 100). Working through inspection hole, remove cotter pin from clevis pin which holds clutch throw-out bracket tie rod to bracket on left vertical fuel tank pocket. Remove clevis pin.

(5) REMOVE CLUTCH THROW-OUT BEARING SHOES (fig. 100). Remove the throw-out yoke trunnion from the bulkhead and lower the yoke. Remove lock plates and drive the bearing shoes from the yoke.

b. Installation.

(1) INSTALL CLUTCH THROW-OUT BEARING SHOES (fig. 100). Insert the shoes in the yoke, and install the lock plates. Raise the yoke into place, and install the trunnion to the bulkhead.

(2) CONNECT RELEASE AND TIE RODS (fig. 100). Position the release and tie rods, and install the clevis pins and cotter pins.

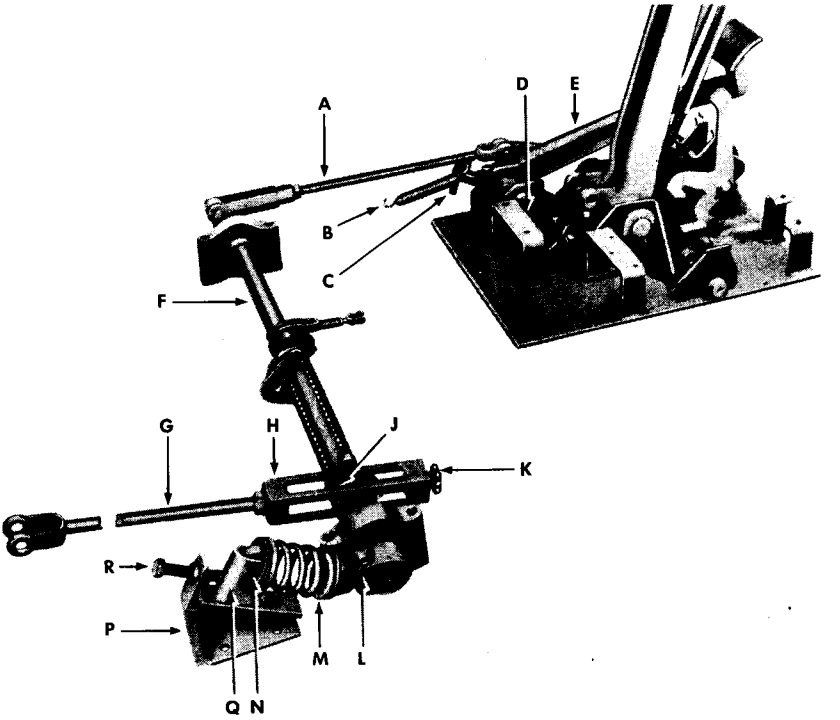
(3) INSTALL FIRE EXTINGUISHER LINES (fig. 100). Install the fire extinguisher lines at the bulkhead. Install the air intake shutter.

(4) INSTALL ENGINE COMPARTMENT INSPECTION PLATE. Raise the plate into position, and install the attaching cap screws.

114. CLUTCH PEDAL AND LINKAGE.

a. Description (fig. 101). The clutch linkage consists of a pedal, pedal return spring, clutch rod, cross shaft, and a clutch rod assembly connected to the release shift fork of the clutch throw-out mechanism. When assembled at the time of manufacture, the clutch pedal and the cross shaft operating lever are mounted on the cross shaft according to index marks on both the lever and the end of the shaft. This is necessary to assure proper operation. When the lever is properly located on the shaft, the center of the hole in the lever, to which the clutch pedal rod is attached, will rest 7 degrees behind a vertical line drawn through the index marks on the lever and the shaft and to

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A—CLUTCH PEDAL ROD ASSEMBLY
B—PEDAL SPRING
C—PEDAL STOP SCREW
D—CLUTCH PEDAL PIN
E—CLUTCH PEDAL
F—CONTROL CROSS SHAFT
G—RELEASE ROD
H—CLUTCH ADJUSTER
J—CLUTCH ADJUSTER LEVER
K—CLUTCH ADJUSTER HANDLE
L—CLUTCH BOOSTER LEVER
M—BOOSTER SPRING
N—SPRING RETAINER
P—BOOSTER SUPPORT BODY
Q—SPRING SUPPORT
R—CLUTCH BOOSTER ADJUSTING SCREW

RA PD 322858

Figure 101 — Clutch Pedal and Linkage

the hull floor below. This may be verified by rotating the lever until index marks are vertical and noting position of the lower end of the arm. CAUTION: *It is important that the length of the clutch pedal rod remain as set at time of manufacture.* A booster assembly, adjustable for pedal pressure, is attached to a bracket on the hull floor and the end of the cross shaft. An adjuster, for pedal free travel, is also attached to the cross shaft and to the clutch rod assembly, leading to the release shaft fork of the clutch throw-out mechanism.

b. Clutch Pedal.

(1) REMOVAL. Remove driver's seat. Remove driver's floor plate by disconnecting hi-idling rods from back of plate (on vehicles so equipped) and removing screws which retain plates to the brackets on the hull floor. Remove pedal return spring. Remove cotter pin and clevis pin from clutch rod at the pedal. Loosen cap screw, securing pedal to pedal shaft. Pull shaft from pedal and out of bracket. Lift out flat washers and the clutch pedal. Loosen jam nut and remove pedal stop screw from pedal.

(2) INSTALLATION. Install pedal stop screw and jam nut. Position pedal at left of shaft bracket. Slide flat washer on pedal shaft, then insert shaft through bracket and pedal. Tighten pedal retaining cap screw. Attach clutch rod to pedal with clevis pin and cotter pin. Install pedal return spring. Install driver's floor plate. Adjust clutch pedal stop screw to allow ¾-inch clearance between the floor and the bottom edge of the stop screw projection. Place driver's floor plate in position and install attaching screws. On vehicles so equipped, connect hi-idling rods to hi-idling levers on rear of floor plate. Install driver's seat.

c. Clutch Rod.

(1) REMOVAL. Remove driver's seat (par. 148 b) and floor plate. Remove pedal return spring. Remove cotter pins and clevis pins attaching rod to pedal and to arm on cross shaft. Lift out rod. NOTE: *In some models the clevis pin which secures clutch rod to arm on cross shaft is installed with the head of the pin toward the bearing. To remove pin, loosen bearing bracket retaining cap screws and move bearing on cross shaft sufficiently to permit removal to the clevis pin.*

(2) INSTALLATION. Do not change length of clutch pedal rod from length set at time of manufacture. If clutch pedal rod length has been accidently changed, however, loosen the clevis lock nut at cross shaft end of the rod, and lengthen or shorten the rod to aline the clevis pin holes with the hole in clutch pedal when pedal is all the way up (clutch engaged) and with ⅛-inch clearance between clutch lever, shoe and face of clutch release bearing. Attach rod to

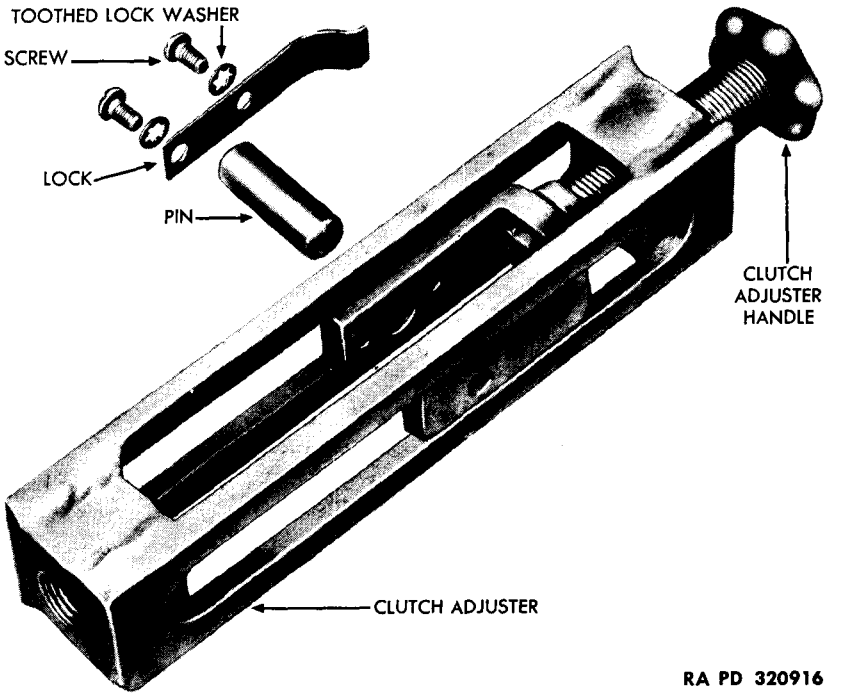


Figure 102 — Clutch Adjuster

arm on cross shaft and to pedal with clevis pins and cotter pins. Install pedal return spring. Install driver's floor plate and seat.

d. Cross Shaft Assembly.

(1) REMOVAL. Remove driver's seat (par. 148 b) and floor plate. Block clutch pedal in full-forward position. Remove lock retaining screws and lock washers from side of clutch pedal adjuster (fig. 102), and lift off lock. Push retaining pin out of adjuster and adjuster lever on clutch cross shaft. Loosen two cap screws which lock booster spring support to booster support body, then loosen jam nut, and back off adjusting screw to relieve tension on spring. Pry out spring and remove spring seats. Remove block and permit clutch pedal to return to normal position. Remove two booster support body retaining nuts and bolts, and lift out support body. Disconnect accelerator and throttle rods from cross shaft tube. Disconnect clutch rod from arm on end of cross shaft. Remove nuts and bolts securing bearing brackets to hull floor, and lift out the cross shaft assembly.

(2) CROSS SHAFT INSTALLATION. Position cross shaft assembly on hull floor. Secure bearing brackets to hull floor with bolts and

nuts. Attach clutch rod to arm on end of cross shaft. Block clutch pedal in full-forward position. Install booster support body assembly. Compress spring in a vise and hold it in compressed position with wire. Remove spring from vise. Position spring seats on end of spring, then position assembly between booster lever on cross shaft and spring support in booster support body. Turn adjusting screw until spring is supported, then remove wire from spring. Position clutch adjuster over lever, and install retaining pin. Install spring lock. Remove block and permit clutch pedal to return to normal position. Connect throttle and accelerator rods to accelerator cross shaft tube. Install driver's floor plate. Check pedal free travel and adjust if necessary (par. 112 **b**). Check pedal pressure and adjust if necessary (par. 112 **b**). Replace driver's seat.

e. Clutch Release Rod.

(1) REMOVAL. Remove crew compartment floor plates and subfloor frame. Remove cotter pin and clevis pin attaching clutch release rod to clutch throw-out bracket equalizer yoke. Block clutch pedal in full-forward position. Remove lock retaining screws and lock washer from side of clutch pedal free travel adjuster (fig. 102). Lift off lock. Push adjuster pin out of adjuster and lever on cross shaft. Then lift the adjuster assembly off cross shaft. Lift clutch rod assembly out through fighting compartment.

(2) INSTALLATION. Block clutch pedal in full-forward position. Push adjuster over lever, and install retaining pin. Install spring lock. Remove block and permit pedal to return to normal position. Connect clutch rod to clutch throw-out bracket equalizer yoke with clevis pin and cotter pin. Check clutch pedal free travel and adjust if necessary. Install crew compartment floor plates and frame.

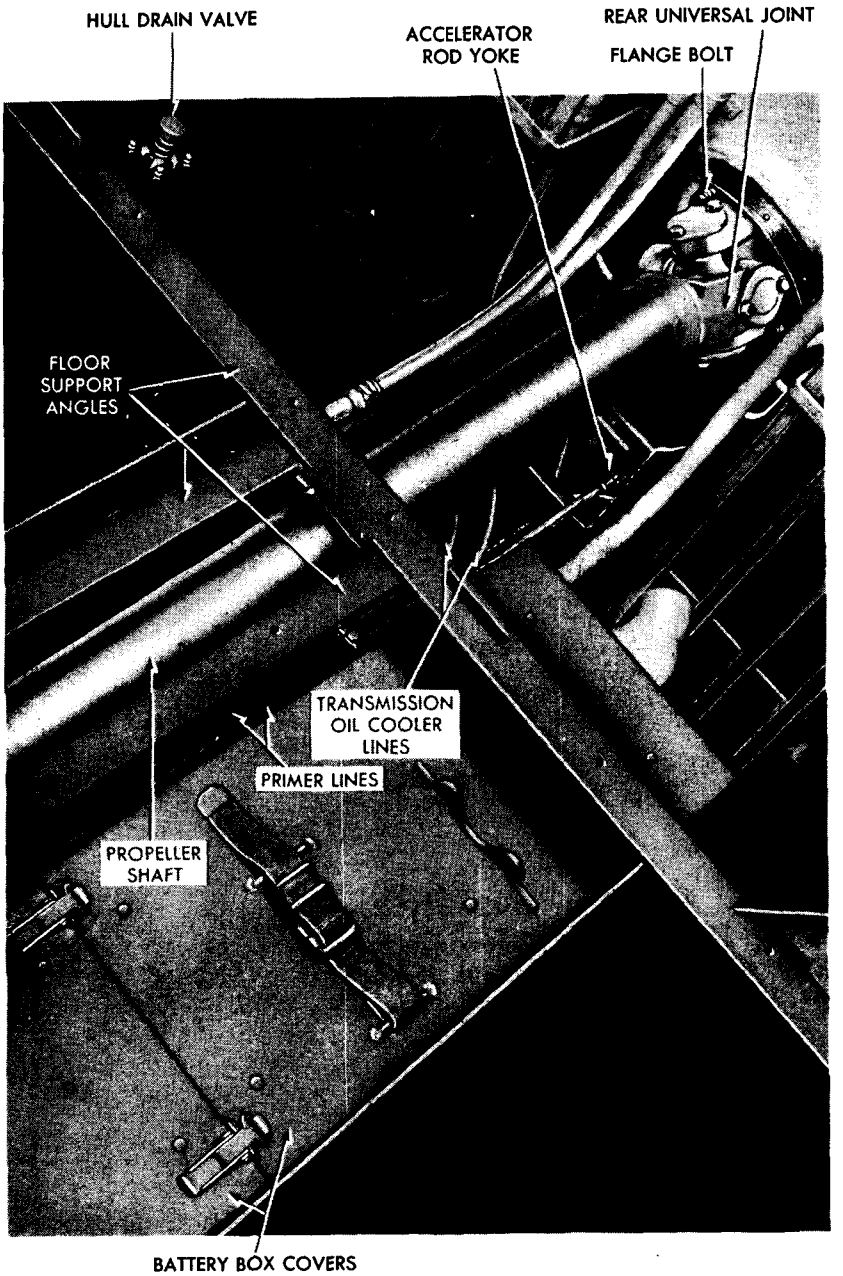
Section XXIV

PROPELLER SHAFT AND UNIVERSAL JOINTS

115. DESCRIPTION.

a. The propeller shaft transmits power from the clutch to the input shaft of the transmission. On late models, the propeller shaft also drives the generator through a generator drive pulley installed on the front universal joint flange. The propeller shaft is of one-piece construction, with two universal joints, one at each end, for operation at an angle between clutch and transmission. The front universal joint is connected to the shaft with a splined slip joint to allow for lengthening or shortening of the shaft and to facilitate removal and replacement.

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Figure 103 — Propeller Shaft Installed

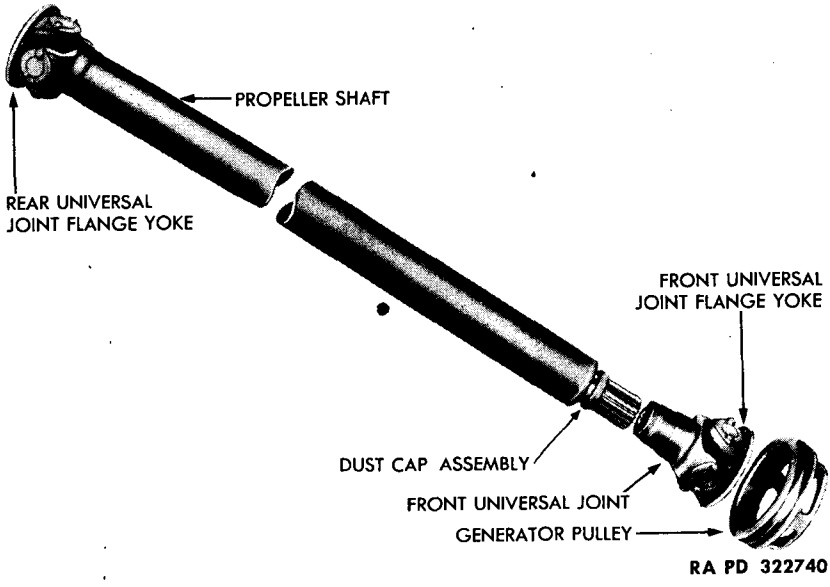


Figure 104 — Propeller Shaft Assembly

116. PROPELLER SHAFT.

a. Description and Data.

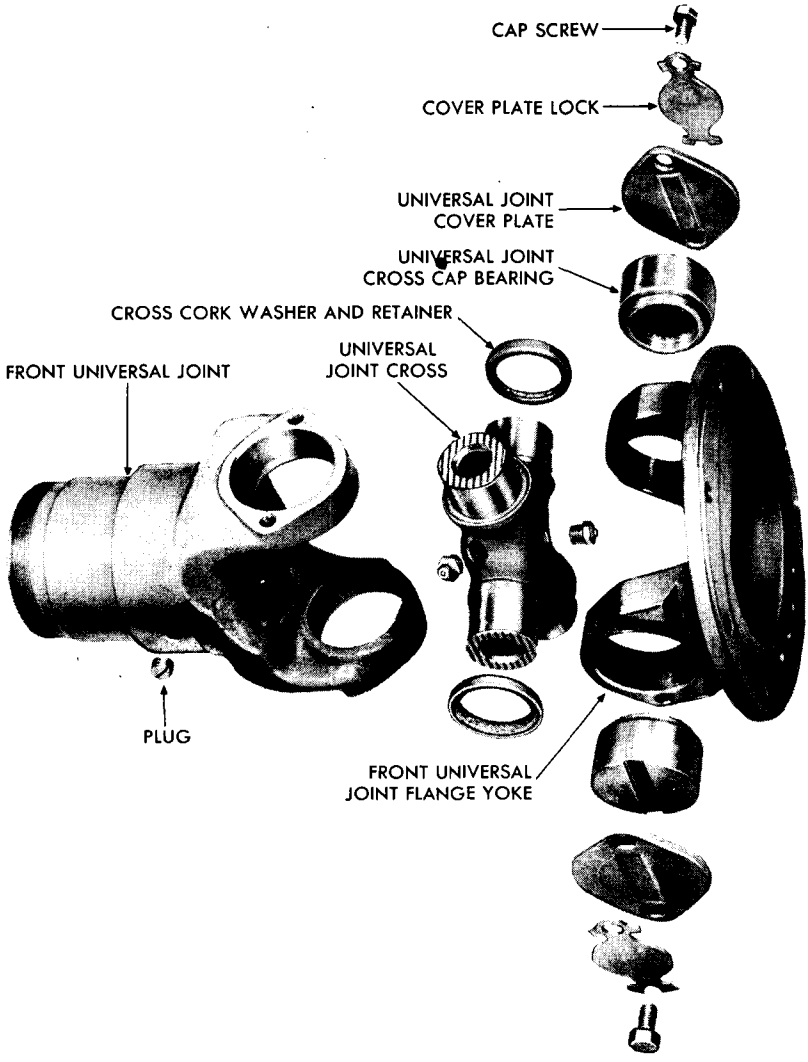
(1) DESCRIPTION. The propeller shaft on late models has a drive pulley attached to the front universal joint flange. On some models, this pulley is installed between the transmission flange and universal joint flange; on other models, the pulley is attached on the rear side of the universal joint flange by four of the eight flange bolts.

(2) DATA.

Manufacturer ..... Spicer Mfg. Co.

b. Removal of Propeller Shaft and Generator Pulley (figs. 103 and 104). If engine has been removed, back off dust cap from front universal joint. Punch-mark splined end of shaft and front universal joint so that the two units can be assembled in same position. Pull the propeller shaft out through engine compartment. If engine has not been removed, remove subfloor plates in crew compartment and floor subframe. Remove bolts which attach rear universal joint flange and companion clutch flange. Punch-mark the two flanges so they can be assembled in same position. Lift out the propeller shaft. Loosen generator drive belts (par. 88 c (2)), and slip the drive belts off generator drive pulley. Remove lock wire and bolts attaching front universal joint, generator pulley, and transmission companion

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Figure 105 — Universal Joint Assembly

flange. Punch-mark the two flanges and the pulley. Lift out the front universal joint and generator pulley.

c. Installation. Place the front universal joint flange in the generator pulley, and line up the punch marks. Place the assembly on the transmission companion flange, and install the flange bolts from the universal joint side. Install nuts and lock-wire. If engine has been removed, place the propeller shaft in position by inserting it through the engine compartment. Grease the splines of the shaft with general purpose grease (par. 21), and insert the splines into the front universal joint with punch marks matching. If engine has not been removed, line up the punch marks on the clutch flange and rear universal joint flange; install flange bolts and lock-wire. Tighten dust cap on front universal joint. Adjust generator drive belts (par. 88 c (2)). Install crew compartment subfloor frame and floor plates.

117. UNIVERSAL JOINTS.

a. Removal.

(1) Remove propeller shaft and front universal joint (par. 116 b).

(2) Remove universal joint cover plates, bearings, and cross (fig. 105). Bend locking plate tabs flat; remove cap screws and cover plates. Push universal joint cross toward bearing to be removed to force bearing out of yoke. Push cross, in same manner, toward the other bearing to be removed. Move cross to one side of flange yoke until opposite end is clear, and lift out cross.

b. Installation.

(1) INSTALL UNIVERSAL JOINT CROSS AND BEARINGS (fig. 105). Install oil seal retainers on cross with the cupped side facing out, and lubricant fitting in cross facing away from flanged yoke. Insert one end of cross in one fork of flanged yoke; opposite end of cross will clear end of other fork and slip into place. Slide slip yoke over cross. Insert cork seals in seal retainers on cross. Lubricate bearings to hold them in position, and insert bearings in yoke openings which enter the universal cross in bearing.

(2) INSTALL BEARING COVER PLATES. Aline the grooves in outer end of bearing to receive the projection on retainer cover plates. Position retainer cover plate, aline holes, and install cap screws with locking plate. Bend tabs over to secure cap screws. Wipe off excess lubricant. Position generator drive pulley (on late models) on front universal joint.

(3) INSTALL PROPELLER SHAFT AND FRONT UNIVERSAL JOINT. Refer to paragraph 116 c.

(4) ADJUST GENERATOR DRIVE BELT. Refer to paragraph 88 c (2).

Section XXV

BRAKES

118. DESCRIPTION.

a. Steering brakes are incorporated in the differential subassemblies located on both sides of the differential. When both steering brakes are applied, evenly and simultaneously, the vehicle slows down or stops in accordance with pressure exerted at steering levers by the driver. If either steering brake is applied independently of, or with greater pressure than, the opposite brake, the track on which the most brake pressure is exerted will decrease in speed and the opposite track will increase in speed. One track cannot be stopped independently of the other; thus some movement occurs in both tracks during turning.

119. STEERING BRAKE SHOES.

a. **Description.** The two brake shoes are three-shoe external contracting brakes, one on each side of the differential assembly.

b. **Removal of Single Anchor Brake Shoe Assemblies.**

(1) DRAIN TRANSMISSION AND FINAL DRIVE. Refer to paragraph 125 b.

(2) REMOVE STEERING BRAKE COVERS. Refer to paragraph 123 a (3).

(3) DISCONNECT STEERING LEVER CONTROL RODS. Remove cotter pins and clevis pins on steering lever control rod upper yokes at left side of differential housing (fig. 106).

(4) DISCONNECT BRAKE SHOES. Loosen jam nut on support screw under lower brake shoe, and turn support screw down as far as possible to provide clearance when removing brake shoe assembly (fig. 106). Remove brake adjusting nut and spring clip from brake adjusting rod. Push end of brake adjusting rod through brake shaft pin and remove washer and spring, being careful not to let them drop inside the housing. End of brake shoe assembly toward front of vehicle is now free, and assembly will slide part way off brake drum and against differential housing. Remove cotter pin from center section of brake shaft and shoe link (fig. 115).

(5) DISCONNECT RIGHT BRAKE SHAFT LEVER. On right side of differential housing, remove cotter pin and clevis pin which attaches steering brake shaft lever rod to right brake shaft lever (fig. 106).

(6) PROVIDE CLEARANCE FOR BRAKE SHOE LINK PIN. Remove three bolts which attach brake shaft trunnion to differential carrier. Pull trunnion out at least 1 inch, moving brake shoe and brake shaft

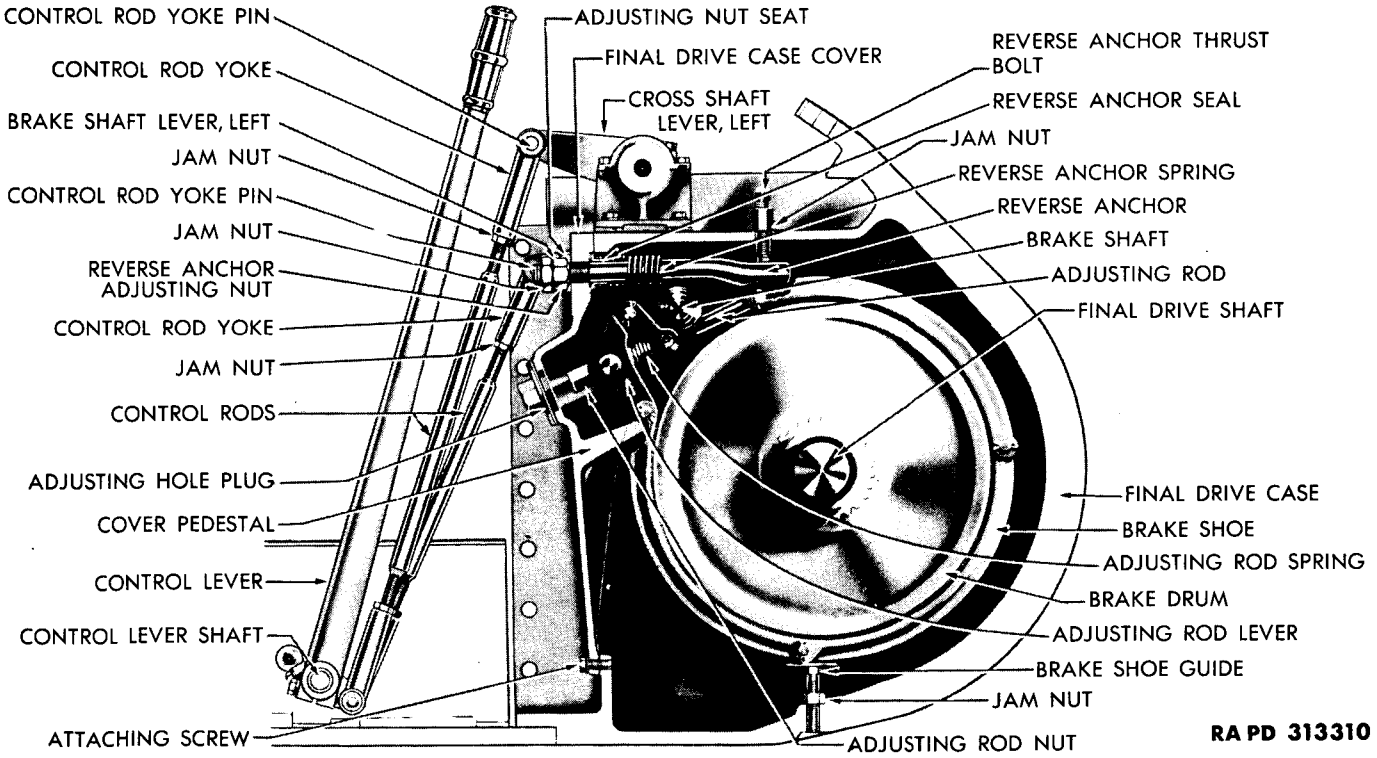


Figure 106 — Cross-section of Steering Brake Mechanism (Double Anchor)

linkage toward outside of housing (fig. 115). This provides clearance to push brake shoe link pin toward center of differential carrier.

(7) REMOVE BRAKE SHOE LINK PIN. Insert screwdriver in groove at end of brake shoe link pin, and pry the pin toward center of differential carrier until brake link is free from brake shaft (fig. 115). Brake shoe assembly is now free. Pin cannot be removed entirely from brake shaft because end of pin strikes differential carrier. It is necessary to manipulate the trunnion so that pin can be moved enough to allow link and shoe assembly to be removed from the shaft.

(8) WITHDRAW SHOE ASSEMBLY. Take hold of rear shoe and pull brake shoe assembly out. Raise hinged sections of brake shoe assembly with pinch bar as they pass over brake supporting screw. Wipe out housing to remove any dirt.

c. Removal of Double Anchor Brake Shoe Assemblies.

(1) DRAIN TRANSMISSION AND FINAL DRIVE. Refer to paragraph 125 **b**.

(2) DISCONNECT STEERING BRAKE CONTROL RODS. Refer to paragraph 123 **b** (2).

(3) REMOVE STEERING BRAKE COVERS. Refer to paragraph 123 **b** (3).

(4) REMOVE STEERING BRAKE REVERSE ANCHOR. Loosen reverse anchor thrust bolt nut. Back out thrust bolt until flush with inside of differential carrier. Lift out the reverse anchor. Remove retainer, seal, and spring (fig. 121) from reverse anchor.

(5) LOWER THE BRAKE SHOE GUIDE. Loosen brake shoe guide screw nut, and screw guide down as far as possible (fig. 107).

(6) REMOVE ADJUSTING ROD LEVER. Remove the adjusting rod adjusting nut with socket wrench (41-W-3329), and remove clip from adjusting rod (fig. 121). Remove cotter pins from inner end of brake shoe long pin and adjusting rod lever pin. Pull top of rear shoe out of differential carrier and withdraw long pin. Lower shoe to bottom of opening. Withdraw adjusting rod lever pin and lift out lever (fig. 109).

(7) REMOVE STEERING BRAKE SHAFT. At right, remove cotter pin from clevis pin at lower end of steering brake shaft lever connecting rod, and remove clevis pin. Examine outer ends of brake shafts to make sure both shafts and levers are marked. If marks are not visible, use a prick punch to mark parts for reassembly in same positions. Remove bolt and lock washer from brake shaft lever, and drive lever off shaft. Remove the three bolts and lock washers from brake shaft trunnion (fig. 108). Slide trunnion and shaft out of carrier until inner end of shaft clears the bushing. Tip inner end of brake shaft down, and move it toward center of vehicle. Pull trunnion off shaft. Remove shaft through brake cover opening (fig. 108).

(8) REMOVE BRAKE SHOE ASSEMBLY. The brake shoe assembly can now be removed by pulling shoes out over top of drum while lifting shoes over brake shoe guides at the bottom (fig. 107). Wipe out differential carrier housing to remove any dirt.

(9) DISASSEMBLE BRAKE SHOES. Remove cotter pins from one end of the two steering brake shoe long pins and the short pin (fig. 121). Withdraw pins to separate shoes, and disconnect adjusting rod.

(10) INSPECT STEERING BRAKE PARTS. Inspect brake drums; if found to be deeply scored, notify higher authority. Examine levers, pins, shafts, and bushings for wear. Replace worn parts. If lining is loose, damaged, glazed, or worn down to $\frac{3}{16}$-inch thickness or less, replace shoes.

d. Installation of Single Anchor Brake Shoe Assemblies.

(1) ASSEMBLE THE BRAKE SHOES. Assemble adjusting rod yoke to rod end of primary (front) brake shoe by installing pin (fig. 119). Insert and spread two cotter pins. Assemble link to one end of a secondary brake shoe, install pin, and insert and spread two cotter pins. Assemble the three shoes by installing the two hinge pins, and insert and spread four cotter pins.

(2) INSTALL BRAKE SHOE ASSEMBLY. See that brake shoe supporting screw is screwed all the way down. Insert yoke end of adjusting rod in end of brake shoe assembly which has two slots, and insert pin. Install and spread cotter pin in each end of adjusting rod yoke pin. Using two wires of sufficient length to encircle brake drum, securely attach one wire to brake adjusting rod. Insert other wire through, and attach it to brake adjusting rod yoke. Pass free ends of both wires under, around, and over top of brake drum. Place brake shoe assembly in position under brake drum; by means of wires, pull brake shoe assembly around brake drum, using pinch bar to support hinged sections as they pass over the supporting screw. When top brake shoe is pulled over drum, fasten wire attached to adjusting rod yoke to brake cross shaft support to hold brake shoe assembly in place.

(3) CONNECT BRAKE SHOE ASSEMBLY. Move trunnion toward outside of differential carrier. Lift link end of brake shoe assembly into position in brake shaft (fig. 115).

(4) INSERT BRAKE SHOE LINK PIN. Position pin connecting link and brake shaft so that groove end is toward center of differential, and manipulate trunnion so that pin can be inserted. Aline cotter pin hole in pin with hole in brake shaft (fig. 115). Use pinch bar or piece of wood to pry brake shoes up to relieve weight of shoes on pin. Insert offset screwdriver in slot in outer end of pin to rotate it and line up cotter pin hole. Insert cotter pin and spread ends.

(5) ASSEMBLE THE ADJUSTING ROD. Remove wire from adjust-

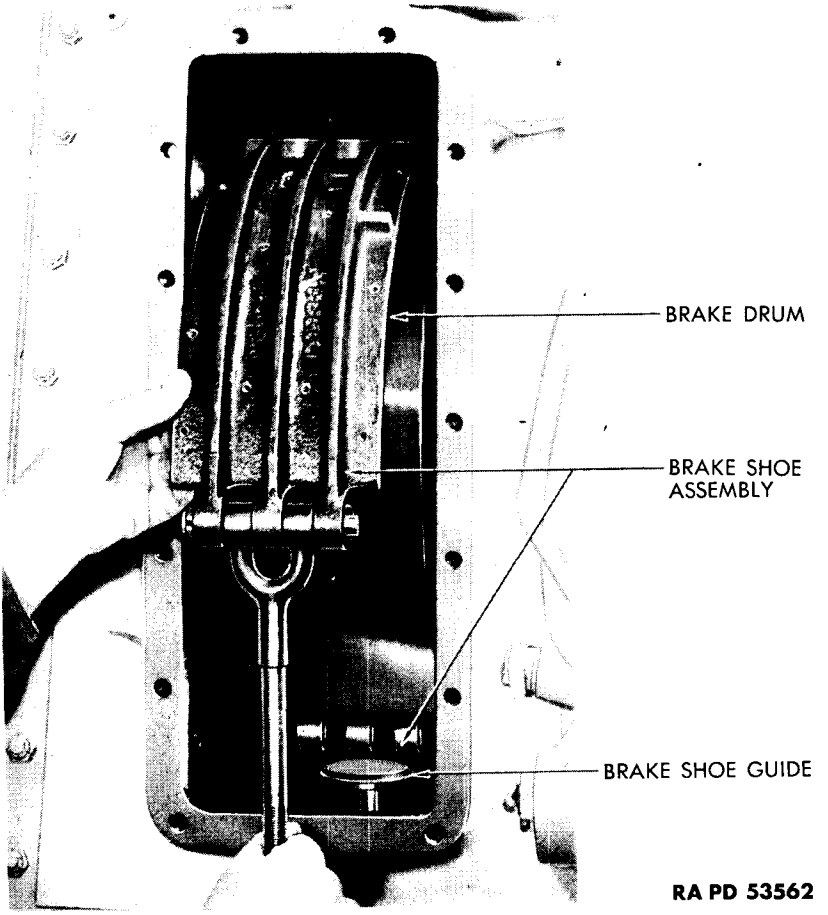


Figure 107 — Installing Brake Shoe in Housing (Double Anchor)

ing rod. Install spring. Hold washer in position on adjusting rod against spring with left hand, pull on wire attached to yoke, and insert adjusting rod in brake shoe rod pin with flat side of pin against washer on rod. Hold adjusting rod in position with wire, and install adjusting nut spring lock with flat side of lock against brake shoe rod pin. With ears on lock in vertical position, screw adjusting nut onto rod with beveled end of nut facing spring lock. Remove wire from adjusting rod yoke.

(6) INSTALL TRUNNION. Position brake shaft trunnion in differential carrier. Install bolts with lock washers and tighten.

(7) ADJUST BRAKES. Make major steering brake adjustment (par. 123 a (6) through (14)).

BRAKES

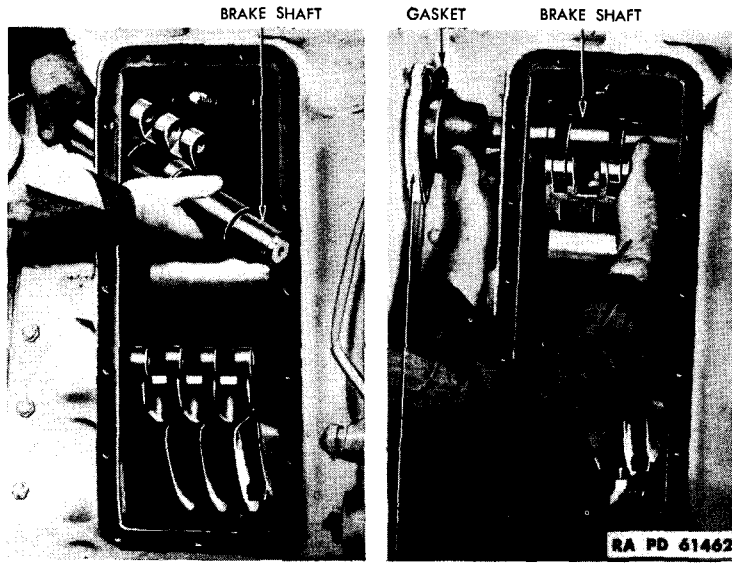


Figure 108 — Installing Brake Shaft and Trunnion (Double Anchor)

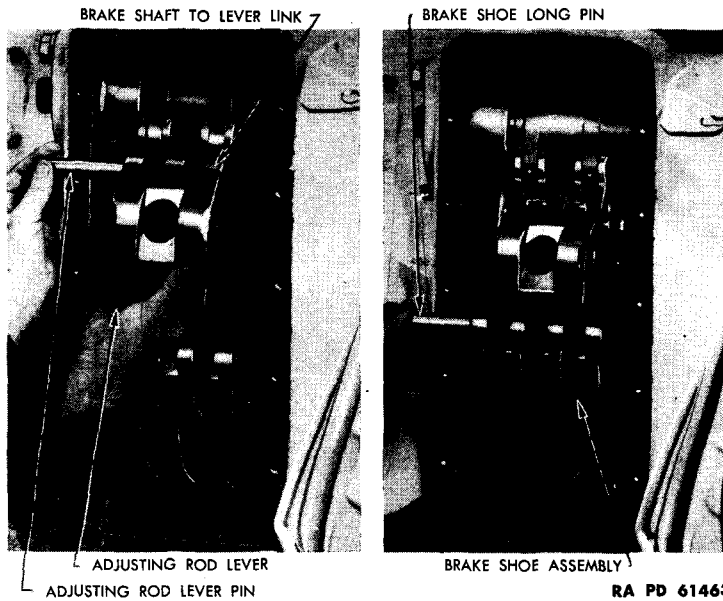


Figure 109 — Adjusting Rod Lever Assembly (Double Anchor)

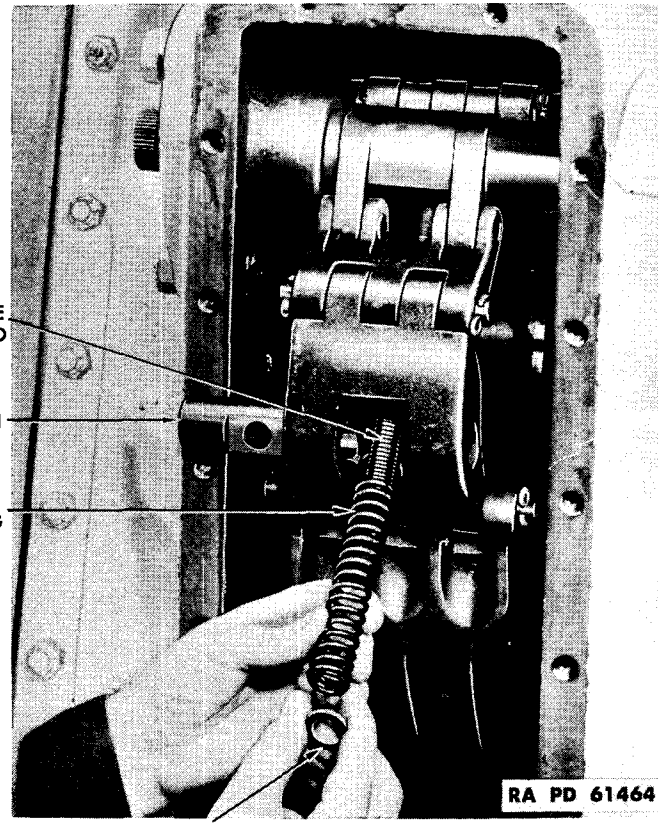


Figure 110 — Installing Adjusting Rod Spring and Washers (Double Anchor)

e. Installation of Double Anchor Brake Shoe Assemblies.

(1) ASSEMBLE STEERING BRAKE SHOE. Use brake shoe assembly (C99330) for the two forward shoes until stock is exhausted, and then use brake shoe assembly (C99331) for all three shoes. Attach adjusting rod to end of forward shoe using short pin (fig. 121). Insert and spread new cotter pin. Connect the other two shoes together and attach them to forward shoe, using long pins. Insert and spread new cotter pins.

(2) INSERT BRAKE SHOE ASSEMBLIES IN DIFFERENTIAL CARRIER. Place upper end of rear shoe on top of brake drum (fig. 107). Feed brake shoes around drum, and guide shoes over brake shoe guide at the bottom.

(3) INSTALL BRAKE SHAFT. Grease a new gasket and position

on flange of brake shaft trunnion. Insert serrated end of brake shaft into brake cover opening and out through trunnion hole (fig. 108). Slide trunnion over end of shaft. Move shaft outward and insert inner end in bushing in differential carrier. Slide trunnion against differential carrier. Install three bolts, with lock washers, and tighten bolts.

(4) INSTALL ADJUSTING ROD LEVER. Connect the upper end of adjusting rod lever to brake shaft to lever link, with the adjusting rod lever pin (fig. 109). Insert and spread new cotter pin. Connect the lower end of lever to brake shoe assembly with brake shoe long pin (fig. 109). Insert and spread new cotter pin.

(5) INSTALL ADJUSTING ROD SPRING AND WASHERS. Slide adjusting rod spring down on rod against shoulder. Place washer on rod against spring. Insert brake shaft pin in lever with flat on pin turned to rear (fig. 110). Center hole in pin with opening in lever, and insert steering brake adjusting rod through hole in brake shaft pin. Place adjusting nut clip on rod with fingers vertical and flat side against brake shaft pin. Screw adjusting rod adjusting nut onto rod with tapered end against clip (fig. 121).

(6) INSTALL BRAKE SHAFT LEVERS. Place brake shaft lever on shaft with reference marks in alinement to assure correct angularity of brake operating mechanism. Drive lever onto shaft so that bolt hole registers with groove in shaft. Install bolt with lock washer and tighten bolt. Attach brake shaft lever connecting rod to right brake shaft lever with clevis pin. Insert and spread new cotter pin.

(7) ADJUST BRAKE SHOE GUIDE CLEARANCE. Refer to paragraph 123 **b** (7).

(8) INSTALL REVERSE STEERING BRAKE ANCHOR. Refer to paragraph 123 **b** (8).

(9) INSTALL BRAKE COVERS. Refer to paragraph 123 **b** (9).

(10) ADJUST REVERSE STEERING BRAKE ANCHOR. Refer to paragraph 123 **b** (10).

(11) ADJUST BRAKE CROSS SHAFT LEVER HEIGHT. Refer to paragraph 123 **b** (11).

(12) ADJUST LEFT STEERING BRAKE SHAFT LEVER HEIGHT. Refer to paragraph 123 **b** (12).

(13) ADJUST STEERING BRAKE CONTROL LEVER STOP SCREWS. Refer to paragraph 123 **b** (13).

(14) ADJUST STEERING BRAKE CONTROL ROD TO LENGTH. Refer to paragraph 123 **b** (14).

(15) ADJUST STEERING BRAKE CONTROL LEVER FREE TRAVEL. Refer to paragraph 122 **b** (1).

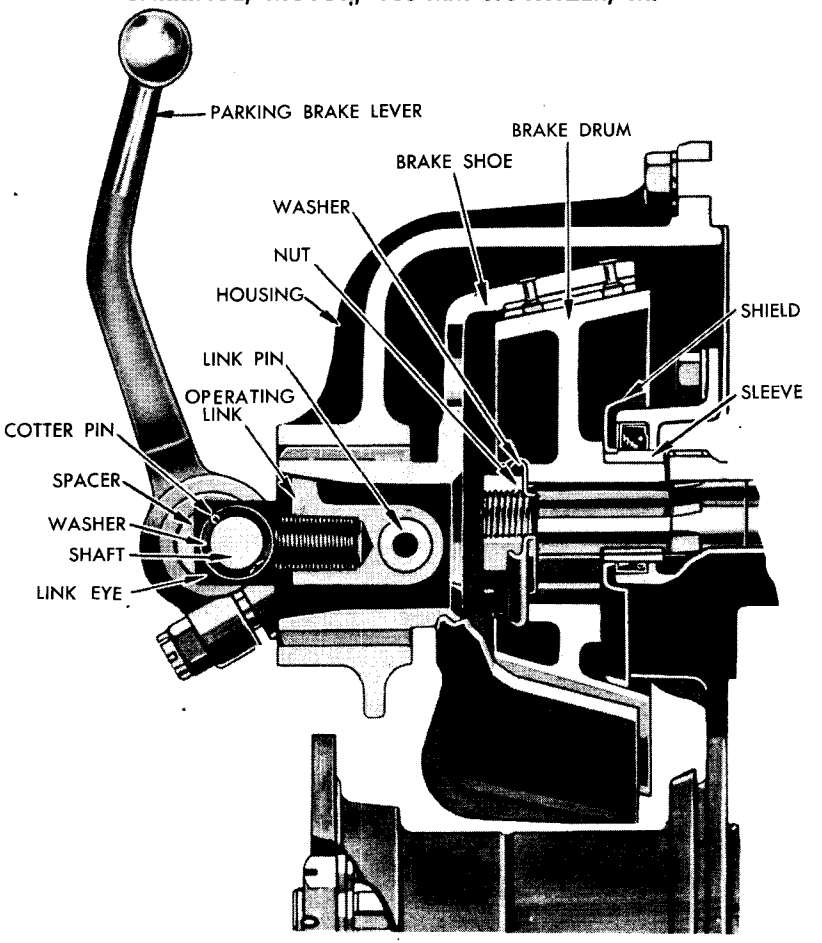


Figure 111 — Transmission Parking Brake, Sectional View

(16) CHECK STEERING BRAKE CONTROL LEVERS FOR EQUAL TRAVEL. Refer to paragraph 122 b (2).

(17) INSTALL ADJUSTING HOLE COVERS. Refer to paragraph 122 b (3).

(18) FILL TRANSMISSION AND FINAL DRIVE WITH OIL. Refer to paragraph 126 f.

120. PARKING BRAKES.

a. Description.

(1) TRANSMISSION PARKING BRAKE. The transmission parking brake used on earlier models, is inside a housing bolted to the rear

of the transmission (fig. 111). Pulling the lever back pushes the brake shoe into contact with the brake drum. The eccentric on the shaft moves the operating link into an overcenter position which locks the brake after it is applied.

(2) BRAKE LOCK MECHANISM. The parking brake on later models consists of two toothed quadrants, one on the forward side of each steering brake lever which is engaged by pawls when a foot pedal is operated, thus holding the steering brake levers in pulled-back position. Kicking the pedal forward sets the brakes, and kicking the pedal back releases them.

b. Adjustment of Transmission Parking Brake. Remove cotter pin and washer from right end of parking brake lever shaft. Slide lever and shaft to left to clear the adjusting eye, removing spacer as shaft is being pulled out. Unscrew adjustable eye in end of toggle link by turning eye counterclockwise (fig. 111), one complete turn at a time so that oilhole in eye will always be on top. Adjust the eye so that when brake lever and shaft are reassembled, considerable effort will be required to pull brake lever back into locked position, and brake and brake shoe will be pressed tightly against drum on output shaft. After adjustment has been made, remove cotter pin from castellated nut on parking brake lever clamping bolt. Loosen nut and reposition lever on shaft so that lever is slightly forward of vertical position. Tighten nut securely, and insert and spread new cotter pin.

c. Removal of Transmission Parking Brake Shoe.

(1) REMOVE PARKING BRAKE LEVER SHAFT. Remove front universal joint cover. Remove cotter pin and washer from right end of parking brake lever shaft, and remove lever and shaft.

(2) REMOVE PARKING BRAKE HOUSING. Remove bolts and lock washers which attach parking brake housing to transmission case cover, and pull housing and shoe off.

(3) REMOVE PARKING BRAKE SHOE. Lift shoe out of housing. Slide link pin out of end of housing, and lift out link.

d. Installation of Transmission Parking Brake Shoe.

(1) ASSEMBLE PARKING BRAKE SHOE. Position parking brake lever shaft link inside splined end of brake shoe, and insert link pin through shoe and link (fig. 111). Place shoe in brake housing so that when housing is installed, projection on the shaft link will be at the top (fig. 111).

(2) INSTALL PARKING BRAKE HOUSING. Place housing with shoe in position over the drum, install attaching bolts with lock washers, and tighten bolts.

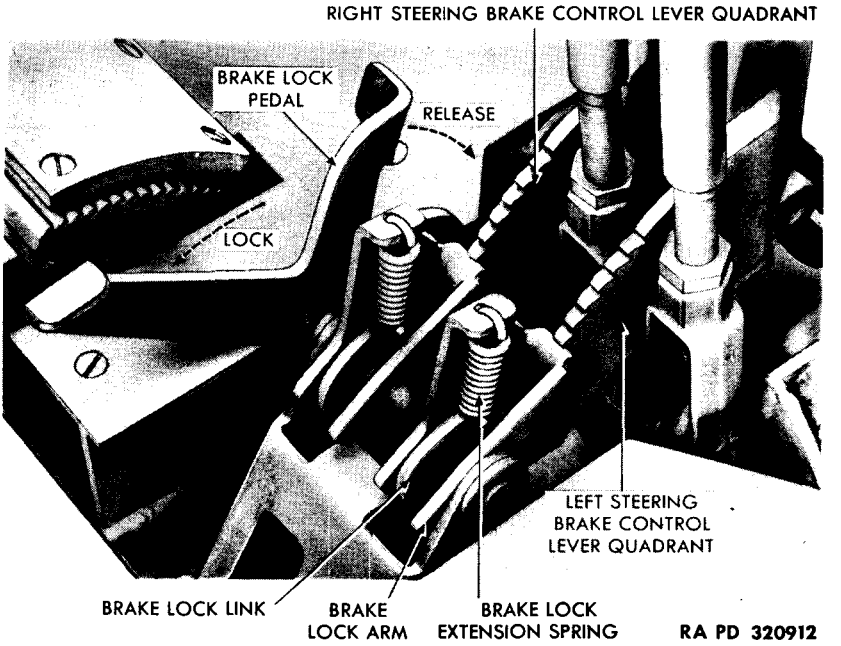


Figure 112 — Brake Lock Mechanism

(3) ASSEMBLE PARKING BRAKE LEVER. Screw shaft link connecting eye part way into link (fig. 111). Insert shaft into housing. Slide shaft to the right, and place spacer over shaft between housing and adjustable eye. Adjust parking brake (subpar. **b** above). Install front universal joint cover. Lubricate linkage and splines in housing with engine oil.

e. Removal of Brake Lock Mechanism — Late Models (fig. 112). Kick brake lock pedal back, and push steering brake levers forward. Pry down and forward on brake lock pawls to release them. Remove pawls and extension springs from brake lock arms.

f. Installation of Brake Lock Mechanism — Late Models. Assemble extension springs and brake lock pawls. Attach extension springs to brake lock arms. Force pawls into position until seated at lower end. Operate brake lock pedal and steering brake control levers to make sure mechanism is working satisfactorily.

121. CONTROLS AND LINKAGE.

a. Description. The steering brake levers are used to steer and stop the vehicle, and operate brake shoes on the two brake drums, one on each side of the differential. Two types of brake levers operate the single anchor or double anchor brake shoes used on

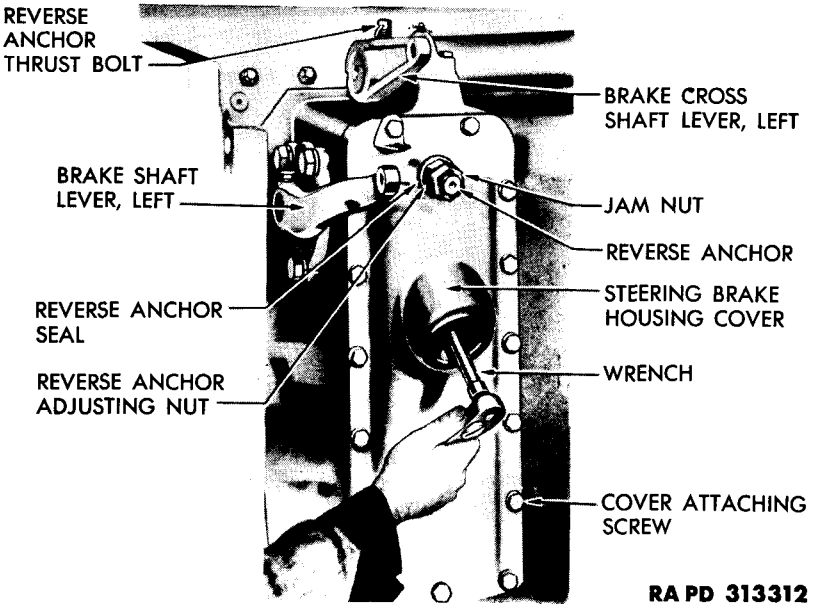


Figure 113 — Adjusting Steering Brake

early and late model vehicles. The single anchor brake is applied when the brake shaft lever moves down, the double anchor brake is applied when the brake shaft lever moves up (fig. 114).

b. Inspect Steering Brake Lever Free Travel.

(1) SINGLE ANCHOR BRAKE. Brake lever free travel should be checked before the vehicle is operated. The free travel is measured at the tops of the levers (fig. 114). Brake lever free travel is the distance the steering lever travels when pulled back (with light pressure only) from fully released position until the brake shoes are felt to seat against the brake drum. On single anchor brakes the recommended minimum free travel is 4 to 5½ inches. When brake lever free travel has increased, due to lining wear, sufficiently to allow lever to come back of vertical position before shoes contact drum, a minor brake adjustment must be made (par. 122 a).

(2) DOUBLE ANCHOR BRAKE. Steering brake control lever free travel should be checked before the vehicle is operated. The free travel is measured at tops of levers (fig. 114). Brake control lever free travel is the distance the lever travels when pulled back (with light pressure only) from fully released position until brake shoes are felt to seat against brake drum. On double anchor brakes the recommended minimum free travel is 4 to 5½ inches. When free travel has increased, due to lining wear, sufficiently to allow

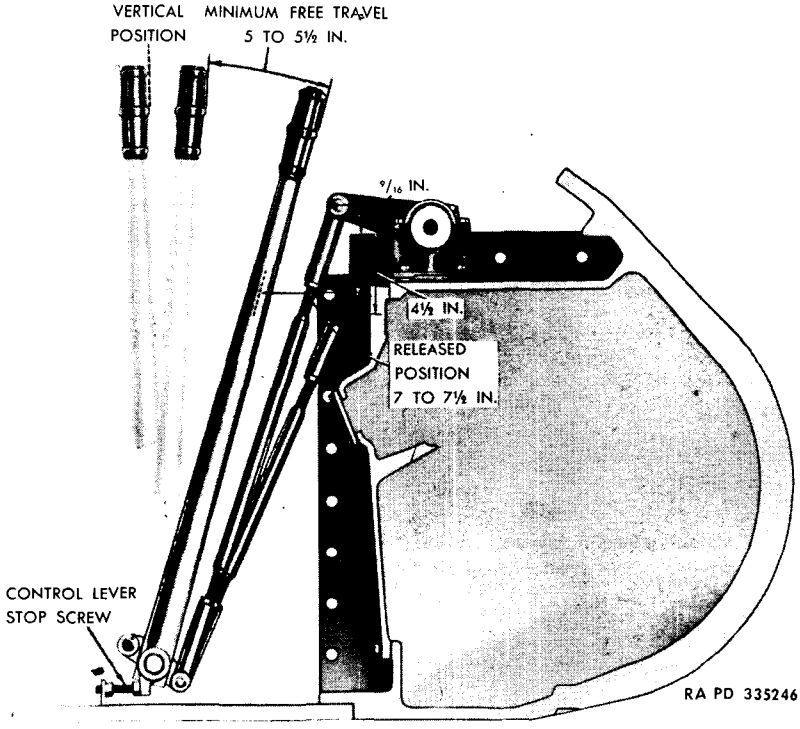


Figure 114 — Steering Control Lever and Brake Shaft Lever Adjustments (Double Anchor)

control lever to come back of vertical position before shoes contact drum, a minor brake adjustment must be made (par. 122 b).

c. Removal of Controls and Linkage.

(1) REMOVE DRIVER'S SUBFLOOR PLATE. Remove driver's seat (par. 140 b). Remove subfloor attaching screws. Disconnect hi-idling rods from hi-idling floor plate lever. Lift out subfloor plate and driver's seat support.

(2) REMOVE HORN SWITCH AND WIRING HARNESS. Remove horn switch wiring harness clip attaching screw and horn switch attaching bolts from right steering brake control lever.

(3) REMOVE STEERING BRAKE CONTROL LEVERS AND RODS (fig. 106). Remove yoke pins connecting steering brake control rods to steering brake control levers. Remove cotter pin at left end of steering brake control lever shaft. Drive shaft out toward transmission, being sure that spacers between levers and at either end of shaft, are not lost. Lift out control levers.

(4) REMOVE STEERING BRAKE CONTROL RODS. Remove yoke pins connecting steering brake control rods to cross shaft lever and left brake shaft lever. Lift out control rods. CAUTION: *Do not change length of rods by adjusting yokes, except when making major adjustments* (par. 123).

(5) REMOVE STEERING BRAKE CROSS SHAFT LEVERS. Remove steering brake lever screws and lock washers. CAUTION: *Pull screws all the way out.* Tap brake cross shaft levers from ends of cross shaft and brake operating shafts.

d. Installation.

(1) INSTALL STEERING BRAKE CROSS SHAFT LEVERS. Slide cross shaft levers onto serrated ends of brake cross shaft and brake operating shafts. CAUTION: *Make sure reference marks on ends of shafts and on levers are in alinement, or brakes cannot be adjusted properly.* Install brake lever screws and lock washers.

(2) INSTALL STEERING BRAKE CONTROL LEVERS AND RODS. Place one spacer on steering brake control lever shaft, and aline right steering brake lever with hole in bracket. Insert shaft through bracket and lever just far enough to allow the other steering brake lever to be installed on shaft. Position left lever, aline hole with shaft, and drive shaft through lever and bracket. Install outer spacer on shaft and cotter pin in end of shaft. Install yoke pins which connect steering brake control rods to steering brake control levers. Install yoke pins which connect control rods to cross shaft lever and left brake shaft lever.

(3) INSTALL HORN SWITCH. Place horn switch wiring harness and horn switch in position in right steering brake lever. Install horn switch attaching bolts and harness clips.

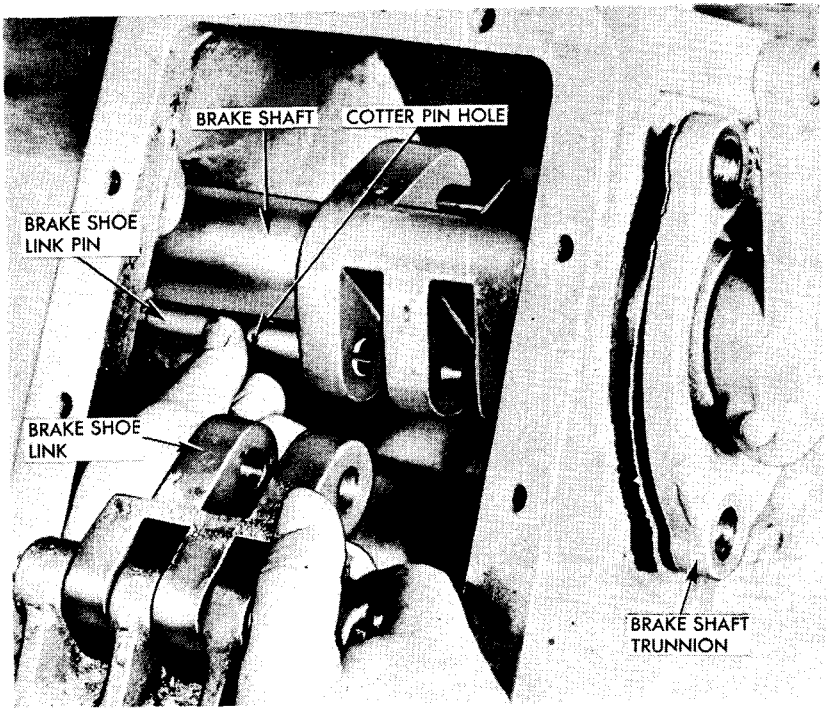
(4) INSTALL SUBFLOOR AND DRIVER'S SEAT. Position driver's subfloor on supports, install attaching screws, and tighten securely. Connect hi-idling rods to hi-idling floor plate lever. Install driver's seat on seat support (par. 148 c).

122. MINOR STEERING BRAKE ADJUSTMENTS.

a. Minor Adjustment of Single Anchor Brakes.

(1) ADJUST STEERING BRAKE LEVER FREE TRAVEL. Unscrew steering brake adjustment opening caps in the right and left steering brake covers (fig. 113). Tighten each brake adjusting nut (fig. 119) the necessary number of notches to adjust free travel of each steering lever to 4 to 5½ inches (fig. 114). CAUTION: *Make sure that wrench socket does not come off extension and drop into housing.*

(2) CHECK BRAKE LEVERS FOR EQUAL TRAVEL. Pull both levers back with equal force, and check for equal lever travel. If travel is



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Figure 115 — Disconnecting Brake Shoe Link From Brake Shaft (Single Anchor)

not equal, tighten adjusting nut on brake controlled by lever having greater travel, until travel of both levers is equal. See that gaskets are serviceable, and install and tighten adjustment opening caps.

b. Minor Adjustment of Double Anchor Brake.

(1) ADJUST STEERING BRAKE CONTROL LEVER FREE TRAVEL. Remove the six bolts and lock washers from each of the two adjusting hole covers, and remove both covers and gaskets (fig. 106). If adjusting rod nut does not have a spring clip, disconnect brake control rod upper yokes from levers, otherwise nut will be damaged. Tighten adjusting rod adjusting nut on each brake until both steering brake control levers have 4 to 5½ inches free travel (fig. 114). CAUTION: *Adjusting nut must be turned so that flats are in contact with clip to lock the nut.*

(2) CHECK STEERING BRAKE CONTROL LEVERS FOR EQUAL TRAVEL. Pull both levers back with equal force, and check for equal lever travel. If travel is not equal, tighten adjusting nut on brake

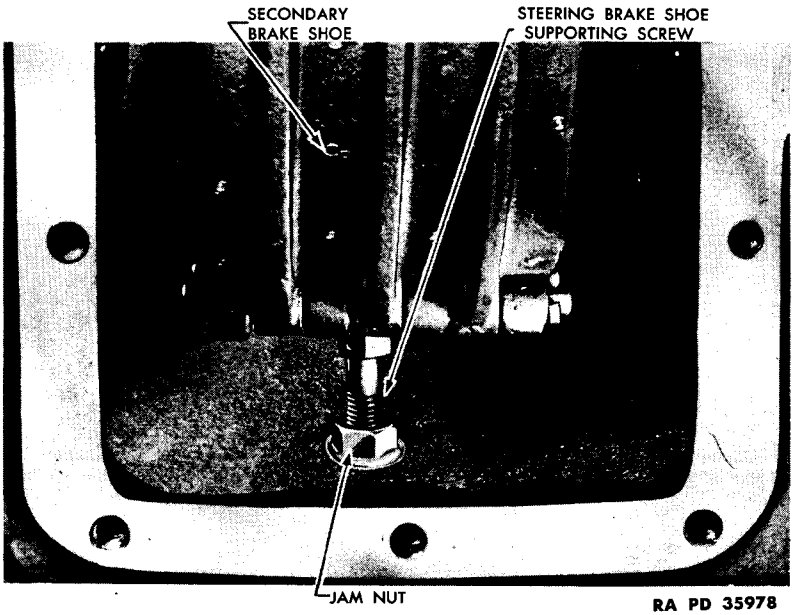


Figure 116 — Brake Shoe Supporting Screw (Single Anchor)

controlled by lever having greater travel, until travel of both levers is equal.

(3) INSTALL ADJUSTING HOLE COVERS. Inspect gasket and if damaged, replace gasket. Position gasket on cover and install cover, using six bolts with lock washers, and tighten bolts. Repeat for cover on opposite side.

123. MAJOR STEERING BRAKE ADJUSTMENTS.

a. Major Adjustment of Single Anchor Brakes.

(1) DRAIN DIFFERENTIAL HOUSING. Remove the two drain plugs and drain oil from differential housing (par. 125 b). If oil is to be used again, drain into clean containers having 38-gallon capacity.

(2) DISCONNECT STEERING BRAKE LEVER RODS. Remove cotter pins and clevis pins from yokes on upper ends of the two rods attached to the steering brake levers.

(3) REMOVE STEERING BRAKE COVERS. Take out the left cover bolts, and remove the cover and gasket. Take out the bolts which attach right cover, and remove the cover and gasket.

(4) PARTIALLY REMOVE RIGHT BRAKE SHOE TO INSPECT LINING. On right brake, loosen jam nut on supporting screw under lower brake shoe, and turn screw down as far as possible (fig. 116). Remove cotter

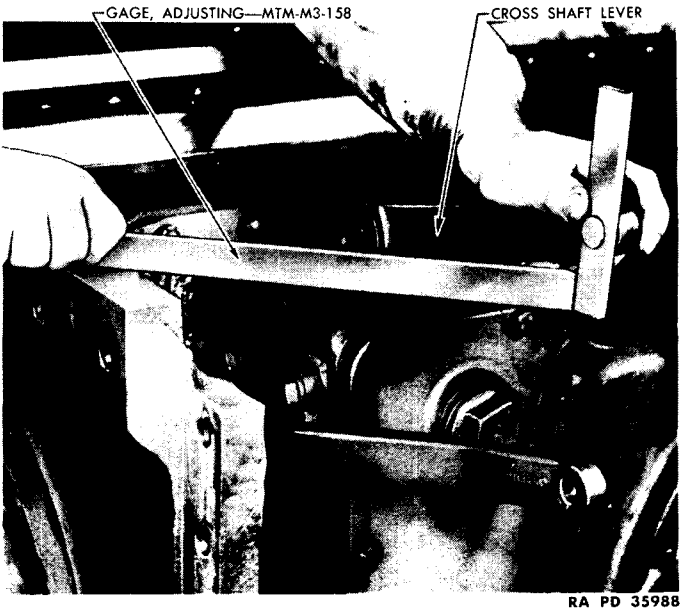


Figure 117 — Positioning Left Cross Shaft Lever 2 Inches Above Machined Surface of Housing (Single Anchor)

pin in center of brake shaft which holds steering brake shoe link pin in brake shaft (fig. 115). Remove cotter pin and the clevis pin which attaches steering brake shaft lever rod to the right steering brake shaft lever. Take out three bolts which attach shaft trunnion to the differential carrier. Pull the trunnion out at least 1 inch, moving brake shaft and brake shoe assembly toward outside of housing (fig. 115). With a screwdriver in groove on inner end of brake shoe link pin, pry the pin toward differential until brake link is free (fig. 115), supporting the rear brake shoe until it is swung down and rests against the cover opening.

(5) INSPECT BRAKE LINING. Inspect the brake shoe lining and linkage (fig. 110). If the lining measures $\frac{3}{16}$ inch thick or less, or if it is glazed and shiny, replace all brake shoes (par. 119 b). Examine the brake drum. If it is deeply scored, notify higher authority before proceeding further. If the brake drum and lining are serviceable, reassemble the brake as follows: Raise the rear brake shoe, and position the brake shoe link so that brake shoe link pin can be pried through link. Install three bolts in brake shaft trunnion and draw up tight. Place the brake shaft lever rod in position, and insert yoke pin and cotter pin which attach it to brake shaft lever. Install cotter

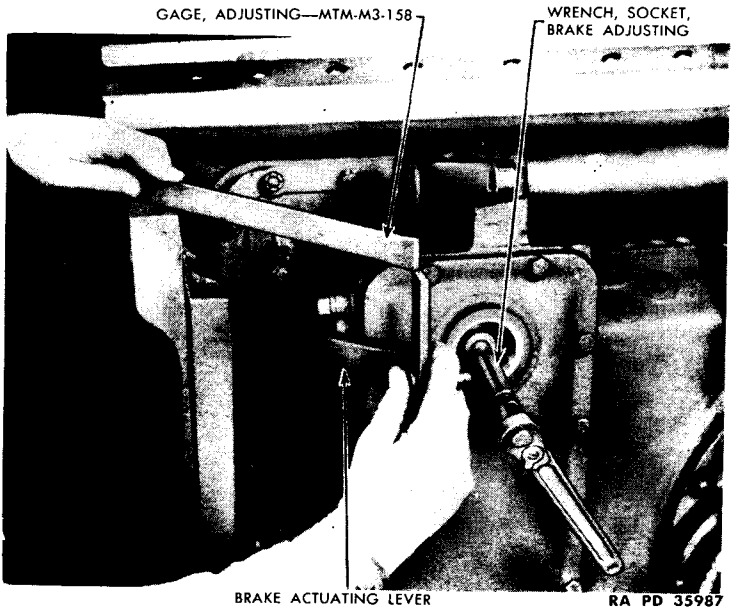


Figure 118 — Positioning Left Brake Shaft Lever 3¾ Inches Below Machined Surface of Housing (Single Anchor)

pin through brake shoe link pin and brake shaft (fig. 115). Continue with the major brake adjustment as follows:

(6) ADJUST BRAKE SHOE SUPPORTING SCREW. In released position the lower shoe on each brake rests on a supporting screw (fig. 116). The height of the screw determines the clearance between the shoes and the drum at the bottom. Loosen jam nut on supporting screw. Press down on brake shaft lever to seat shoes against drum. Adjust height of supporting screw so that a 0.010-inch feeler can be passed with slight drag between the head of the supporting screw and point of contact on brake shoe. Tighten jam nut, and recheck the clearance.

(7) ADJUST CROSS SHAFT LEFT LEVER. Apply only enough pressure to lever on left end of cross shaft to seat the linings on the shoes of the right brake against the brake drum. While this pressure is being applied, screw the adjusting nut on the right brake to position lever on left end of cross shaft so that center of clevis pin hole in end of lever is exactly 2 inches above top horizontal machined surface on left side of differential housing (fig. 117). Tightening the brake adjusting nut, by turning to the right (clockwise), raises the lever. Loosening the brake adjusting nut, by turning to the left (counterclockwise), lowers the levers.

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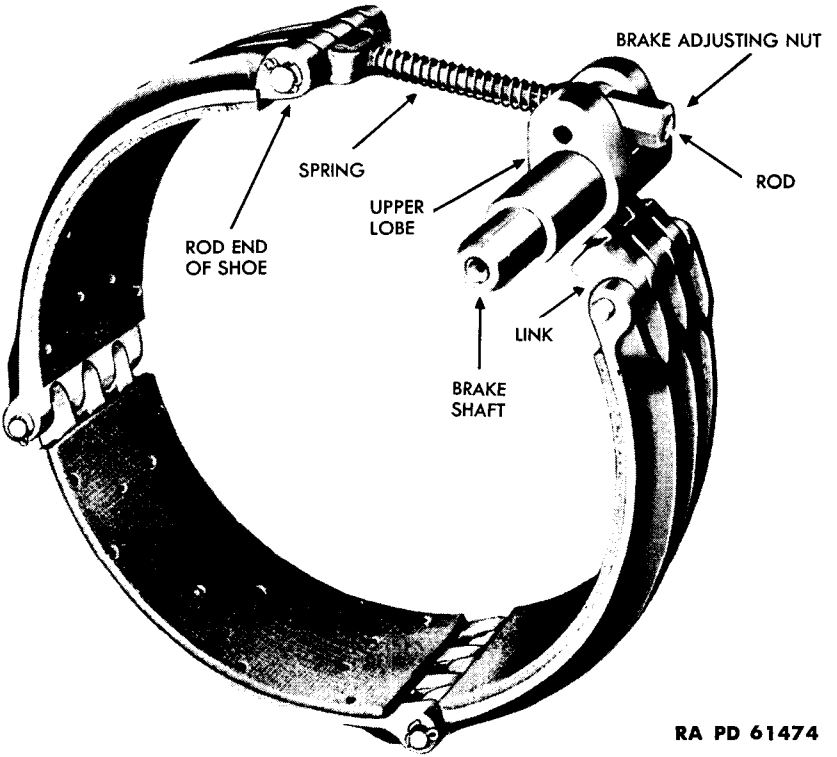


Figure 119 — Brake Shoe and Brake Adjusting Rod Assembled to Brake Shaft (Single Anchor)

(8) ADJUST LEFT BRAKE SHAFT LEVER. Apply only enough pressure to left brake shaft lever to seat linings on shoes of left brake against brake drum. While this pressure is being applied, screw adjusting nut on left brake to position left brake actuating lever so that center of clevis pin hole in end of lever is exactly 3¾ inches below top horizontal machined surface on left side of differential housing (fig. 118).

(9) INSTALL STEERING BRAKE COVERS. See that gaskets on steering brake covers are serviceable, and install covers.

(10) ADJUST STEERING LEVER STOP SCREWS. The steering brake levers must be set in correct released position before further adjustment is made. When in correct released position, the center line of steering lever is 7 to 7½ inches from face of steering brake cover at the top (fig. 114). If steering levers are not in correct position, loosen

jam nuts and adjust stop screws in lower end of levers, then tighten jam nuts.

(11) ADJUST STEERING LEVER CONNECTING RODS. Adjust yoke on right steering lever control rod so that clevis pin hole in yoke lines up with clevis pin hole in cross shaft left lever when lever is 2 inches above top horizontal machined surface on left side of differential housing (fig. 117), and brake shoes are in contact with the drum. Install clevis pin. Insert and spread new cotter pin. Tighten jam nut on yoke. Repeat procedure for left rod, and connect rod to left brake shaft lever when lever is 3¾ inches below surface of differential housing (fig. 118).

(12) ADJUST STEERING BRAKE LEVER FREE TRAVEL. The brake shoes must be adjusted to provide sufficient clearance between shoes and drum when steering brake lever is in fully released position. This clearance is represented by steering brake lever free travel measured at top of lever. Back off brake adjusting nut on each brake approximately six notches. Make sure flats of nut are squarely in contact with fingers on clip. Test steering brake lever free travel, which should be 4 to 5½ inches (fig. 114).

(13) CHECK BRAKE LEVERS FOR EQUAL TRAVEL. Pull both levers back with equal force, and check for equal lever travel. If travel is not equal, tighten adjusting rod nut on brake controlled by lever having the greater travel, until travel of both levers is equal.

(14) REFILL POWER TRAIN (par. 126 f).

b. Major Adjustment of Double Anchor Brake.

(1) DRAIN POWER TRAIN. Remove drain plugs and drain oil from power train (par. 125 b). If oil is to be used again, drain into clean containers having 43-gallon capacity.

(2) DISCONNECT STEERING BRAKE CONTROL RODS. Remove cotter pins and clevis pins from yokes on upper ends of brake control rods (fig. 106). Pull levers and rods back out of the way.

(3) REMOVE STEERING BRAKE COVERS. Make sure master battery switch is off. Remove jam nut, adjusting nut, and seat from reverse steering brake anchor (fig. 106). Take out bolts with lock washers which attach toeguard on left side. Remove toeguard. Take out remaining bolts with lock washers which attach brake cover to differential carrier, and lift out brake cover and gasket. Repeat procedure to remove brake cover on opposite side.

(4) PARTIALLY REMOVE RIGHT BRAKE SHOE TO INSPECT LINING. Swing rear end of anchor down, and lift out reverse steering brake anchor with spring, seal retainer, and seal (fig. 120). Loosen brake

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

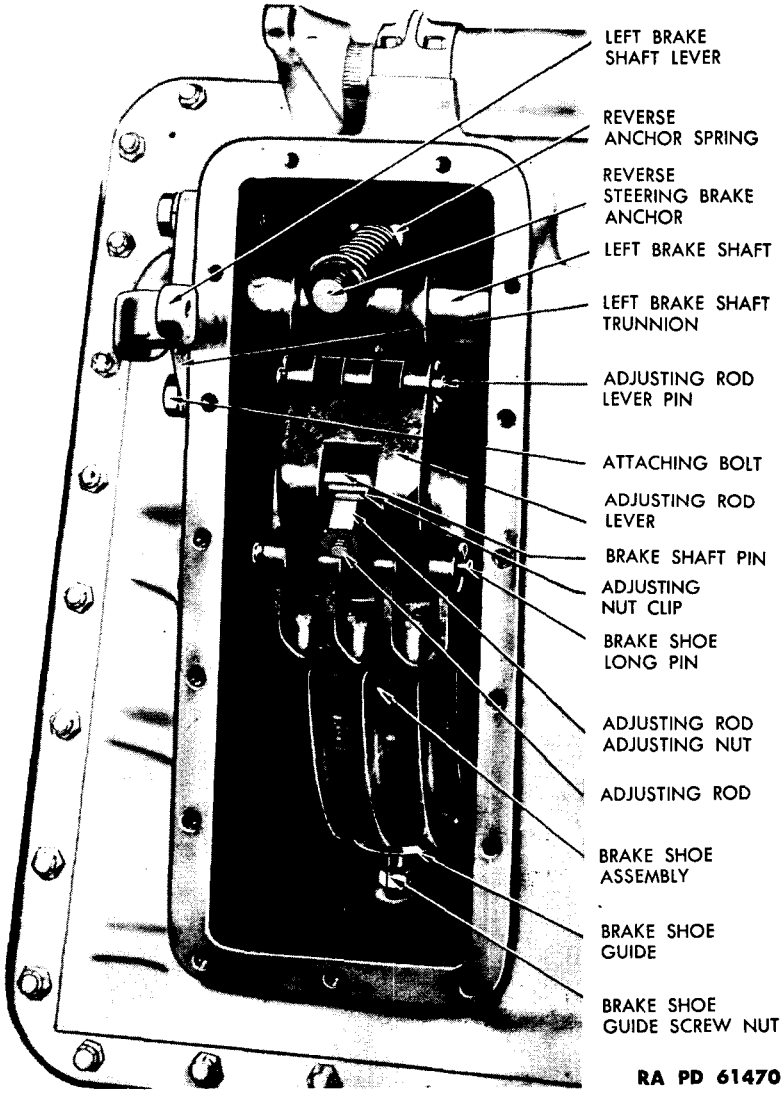


Figure 120 — Steering Brake Cover Removed, Showing Brake Operating Mechanism (Double Anchor)

shoe guide screw nut, and screw guide all the way down (fig. 107). Remove adjusting rod adjusting nut and remove clip. Remove cotter pin from inner end of long pin at top of rear brake shoe (fig. 120). Pull top of brake shoe back out of carrier, and withdraw the long pin.

(5) INSPECT BRAKE LINING. Inspect the brake shoe lining (fig. 121). If the lining measures $\frac{3}{16}$-inch thick or less, or if it is glazed and shiny, replace all brake shoes (par. 119 c). Examine brake drum. If it is deeply scored, notify higher authority before proceeding further.

(6) REASSEMBLE RIGHT BRAKE. If the brake drum and lining are serviceable, reassemble the right brake. Connect lower shoe to steering brake shoe adjusting rod lever with long pin. Insert new cotter pin and spread. Install spring and washer on adjusting rod (fig. 110), and insert rod through brake shaft pin. Place adjusting nut clip on rod with flat against brake shaft pin. Screw adjusting rod adjusting nut, tapered end first, onto rod two to three full turns (fig. 120).

(7) ADJUST BRAKE SHOE GUIDE CLEARANCE. The lower shoe on each brake rests on a brake shoe guide (fig. 120). Tighten adjusting rod adjusting nut until shoes are snug against drums. Loosen brake shoe guide screw nut (fig. 120). Adjust height of brake shoe guide so that a 0.010-inch feeler will pass, with slight drag, between the guide and the lowest point of the brake shoe. Tighten nut and recheck clearance. This adjustment will provide 0.010-inch clearance between lining and drum with brakes in released position. Repeat for opposite brake.

(8) INSTALL REVERSE STEERING BRAKE ANCHOR. Install spring on reverse steering brake anchor. Place reverse anchor seal retainer on anchor with flat side against spring. Slide reverse anchor seal onto anchor so that shoulder is seated in retainer with sleeve projecting through retainer and into spring (fig. 121). Place anchor in position under thrust bolt with end hooked over adjusting rod yoke (fig. 106). Loosen nut, then tighten reverse anchor thrust bolt as required to hold anchor in place.

(9) INSTALL BRAKE COVERS. Make sure gasket surfaces of differential carrier and both steering brake covers are clean. Grease new gasket and position on cover. Start reverse steering brake anchor through hole in cover. Guide cover into position on differential carrier so that pedestal on inside of cover supports lower end of adjusting rod lever (fig. 106). It may be necessary to raise up on brake shaft lever, or raise cover up with a drift to aline the bolt holes. Install bolts, with lock washers, at top and bottom, but do not tighten. On left side attach toeguard to cover with second, third, and fourth bolts from the bottom. Install remaining bolts with lock washers. Tighten cover bolts evenly to compress gasket uniformly. Place reverse anchor

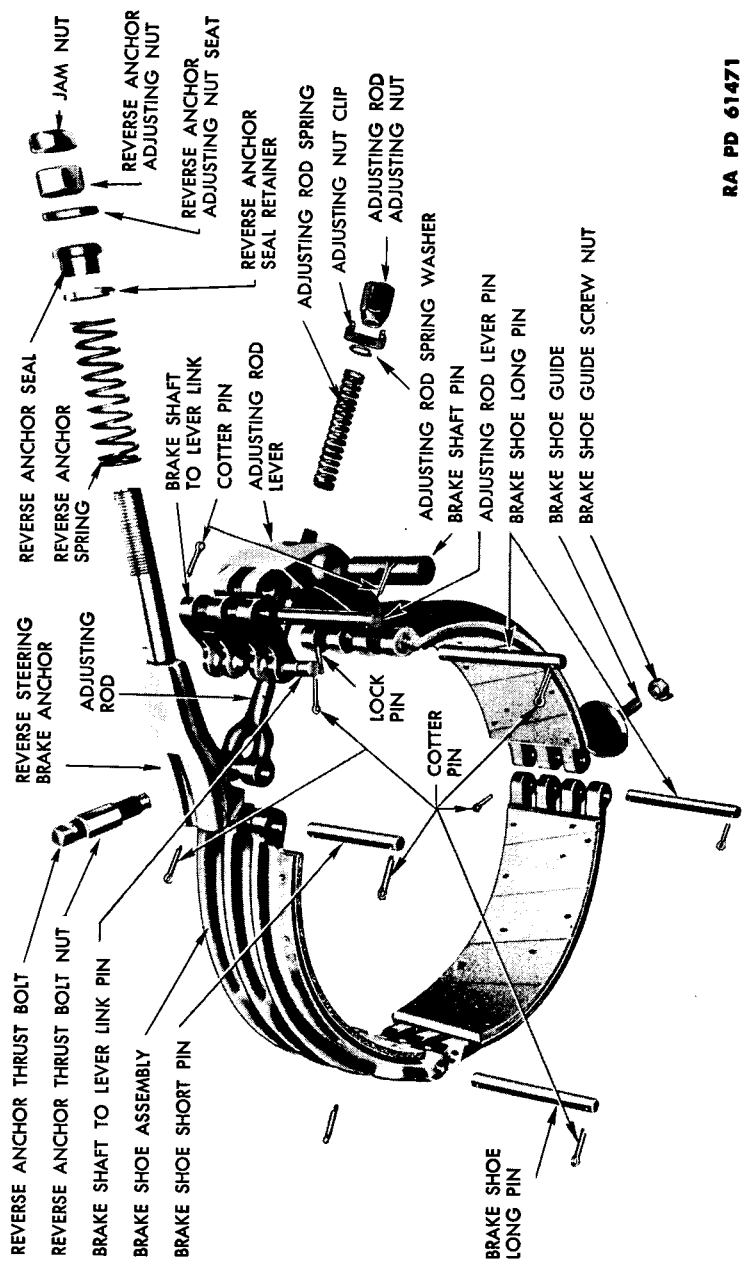


Figure 121 — Steering Brake Shoe Mechanism Disassembled (Double Anchor)

adjusting nut seat on end of anchor with flat side against steering brake cover (fig. 106). Screw reverse anchor adjusting nut on anchor with beveled side against the seat. Screw jam nut on anchor against adjusting nut.

(10) ADJUST REVERSE STEERING BRAKE ANCHOR. Turn reverse anchor thrust bolt down until it is felt to contact anchor, then back off thrust bolt one full turn to provide proper clearance. Hold bolt and tighten thrust bolt nut (fig. 106). Turn reverse anchor adjusting nut down until anchor is felt to contact forward brake shoe, then back off 1½ turns. Hold adjusting nut and tighten jam nut.

(11) ADJUST BRAKE CROSS SHAFT LEFT LEVER HEIGHT. Remove adjusting hole cover and gasket from right steering brake cover. Turn adjusting rod adjusting nut. Pull up on lever, and turn adjusting nut to position the brake cross shaft left lever so that center of clevis pin hole is $\frac{9}{16}$ inch above machined edge of differential carrier housing (fig. 114) with brake shoes in contact with drum.

(12) ADJUST LEFT STEERING BRAKE SHAFT LEVER HEIGHT. Remove adjusting hole cover and gasket from left steering brake cover. Pull up on lever, and turn adjusting rod adjusting nut to position the left steering brake shaft lever so that center of clevis pin hole is 4½ inches below machined edge of differential carrier housing (fig. 114) with brake shoes in contact with drum.

(13) ADJUST STEERING BRAKE CONTROL LEVER STOP SCREWS. Loosen lock nuts on steering brake control lever stop screws (fig. 114). Adjust screws so the distance from face of left brake cover at top of center line of levers is 7 to 7½ inches with levers in forward position (fig. 114). Tighten lock nuts.

(14) ADJUST STEERING BRAKE CONTROL ROD LENGTH. Loosen steering brake control rod yoke jam nuts at top of rods. Position control levers forward against stop screws (fig. 106). Adjust yoke so that holes in left rod in yoke are alined with hole in left brake shaft lever when center of lever hole is 4½ inches below edge of differential carrier housing (fig. 114), and brake shoes are in contact with drum. Insert clevis pin through rod yoke and lever. Install and spread new cotter pin in clevis pin. Tighten control rod yoke nut. Adjust yoke on right control rod so that holes in yoke are alined with hole in brake cross shaft left lever when center of lever hole is $\frac{9}{16}$ inch above edge of differential carrier housing (fig. 114), and brake shoes are in contact with drum. Insert clevis pin through rod yoke and lever. Install and spread new cotter pin in clevis pin. Tighten control rod yoke nut.

(15) ADJUST STEERING BRAKE CONTROL LEVER FREE TRAVEL. Refer to paragraph 122 b (1).

(16) CHECK STEERING BRAKE CONTROL LEVERS FOR EQUAL TRAVEL. Refer to paragraph 122 b (2).

(17) INSTALL ADJUSTING HOLE COVERS. Refer to paragraph 122 b (3).

(18) FILL POWER TRAIN WITH OIL. Refer to paragraph 126 f.

Section XXVI

TRANSMISSION AND FINAL DRIVE ASSEMBLY

124. DESCRIPTION.

a. General (fig. 122). The transmission and final drive assembly, or power train, is an assembly consisting of the transmission, controlled differential with steering brakes, and the final drives to which the track driving sprockets are attached. The units are bolted to, or assembled in, a large one-piece casting called the differential housing. This housing is bolted to the hull and forms the front part of the vehicle. The final drive units can be removed as separate assemblies with the power train in the vehicle. The steering brakes are adjusted and brake shoe assemblies can be replaced with the power train in the vehicle. The transmission and the differential housing assembly are always removed or installed after the power train is removed from the vehicle.

b. Transmission (fig. 122). The transmission is an extra-heavy-duty type with five forward speeds and one reverse. The transmission case is bolted to the differential carrier. The pinion which drives the differential bevel drive gear (ring gear) is mounted on the forward end of the transmission output shaft.

c. Differential. The differential permits the outer track to travel faster than the inner track on turns, or one track to travel faster than the other on uneven ground. Because the differential is the controlled type, it also provides a means of steering and stopping the vehicle. When the brake on either brake drum is applied, it puts a planetary gear train on that side of the differential into motion. As a result, the track on the same side of the vehicle as the brake which is being applied, is slowed down, the other speeded up, and the vehicle steers to the side of the slower moving track. Because of the arrangement of the gears, the inner track can never be completely stopped when making a turn, as long as the outer track is moving, regardless of the force applied on the steering brake. This provides the vehicle with greater stability, making it safer to steer under all conditions.

d. Final Drive (fig. 122). The two final drive assemblies are bolted to the ends of the differential housing. The track driving sprockets are attached to a hub on each end of the final drive assemblies.

TRANSMISSION AND FINAL DRIVE ASSEMBLY

125. TRANSMISSION AND FINAL DRIVE REMOVAL.

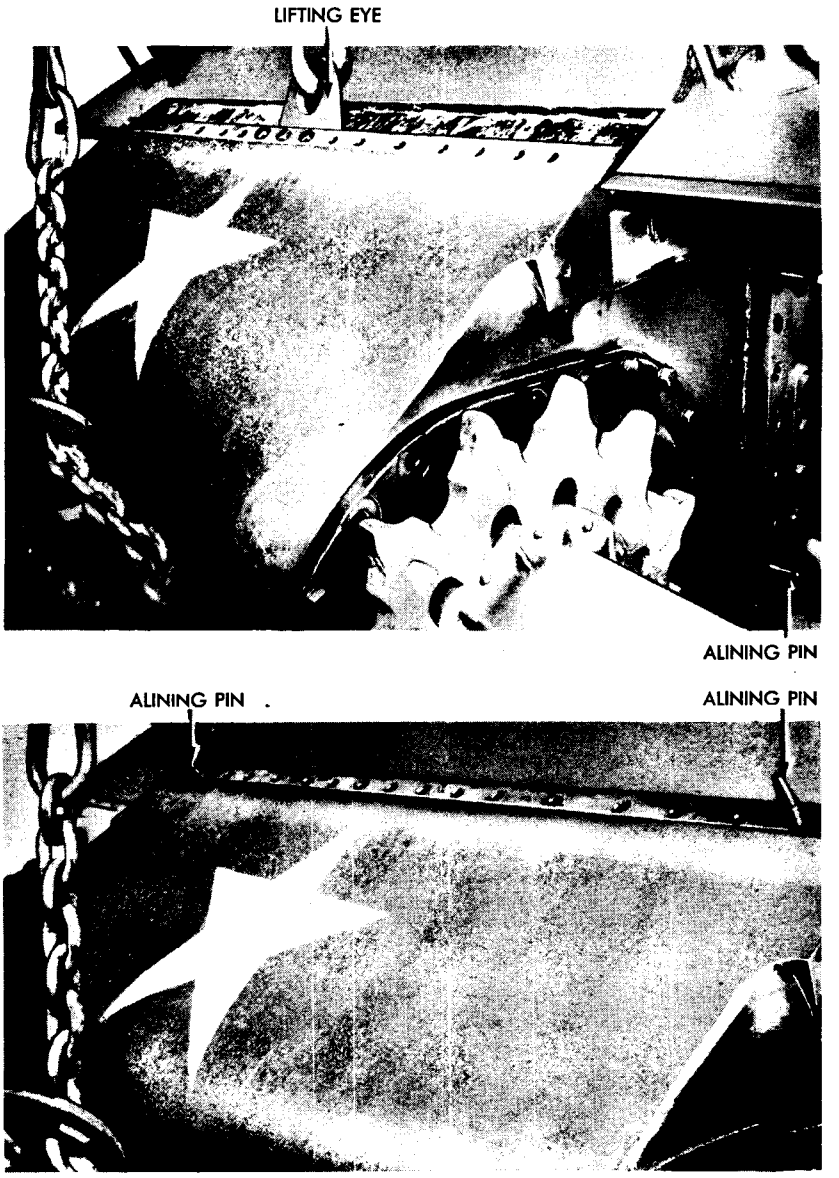
a. General. The using arm is authorized to remove and install a transmission and final drive assembly. However, the replacement of this assembly with another assembly must not be done by the using arms unless authorization is received from ordnance personnel. Removal of the transmission and final drive assembly from the vehicle is a major operation that will require several hours. Because of its size and weight a removing and replacing fixture (41-F-2997-220) and wrecker are necessary to remove the assembly.

b. Drain Oil From Transmission and Final Drive Assembly. Remove three drain plugs: one under each final drive housing, and one in the transmission housing. Clean the magnetized plugs and install them.

c. Remove Front Sand Guard and Fenders. Release the bayonet-type fasteners, and remove one cap screw and lock washer which attach front sand guard to center guard, hull, and front fender. Loosen two final drive cover cap screws which secure front sand guard to final drive cover, and lift off the front sand guard. Remove nuts, bolts, cap screws, and lock washers which attach front fender to hull and power train housing, and lift off the fender. Remove opposite front sand guard and fender in the same manner.

d. Disconnect Track on Both Sides (par. 134 a).

e. Disconnect Attached Parts from Transmission and Final Drive Assembly (fig. 123). Open battery master switch. Remove driver's seat (par. 148 b) and subfloor plate by disconnecting hi-idling rods and removing attaching screws. Remove generator drive belt guard. Loosen generator adjusting arm bolts, and rotate generator toward propeller shaft. Remove drive belts from generator pulley. Remove lock wire and bolts attaching front universal joint, generator drive pulley, and transmission companion flange. Unscrew knurled nuts which secure speedometer and tachometer cables to adapters at upper rear end of transmission. Remove clips which hold flexible shafts to transmission, and bend shafts into left sponson, out of the way. Remove horn switch attaching bolts from right steering brake lever. Remove horn switch wiring harness clips. Disconnect transmission to oil cooler tubes from left side of transmission. Unscrew coupling nuts which secure fuel priming lines to priming pump. Pull lines out from around steering brake cross shaft. Remove hand throttle bracket attaching screws. Remove bolt and cap screw which secure transmission filler pipe bracket. Remove bracket. Unscrew transmission filler and lift it out of vehicle. Cover top of transmission filler opening with cloth and secure with wire. Remove stowage box attaching cap screws from stowage box at right of transmission. Lift



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Figure 124 — Removing Power Train Unit, Using Special Fixture (41-F-2997-200)

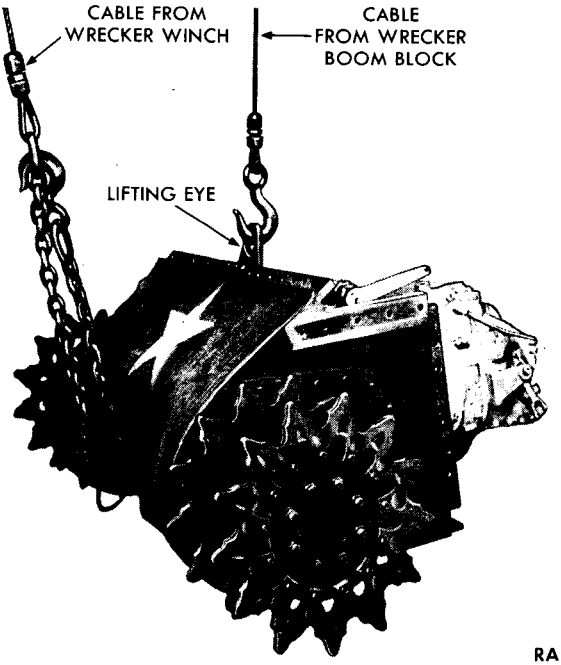


Figure 125 — Power Train Unit Removed

out box. Disconnect steering brake control rod upper yokes from steering brake cross shaft lever and steering brake shaft lever. Loosen lock nut, remove attaching cap screws from transmission hull brace, and unscrew brace from transmission.

f. Remove Transmission and Final Drive Assembly. Hold nuts inside hull and remove the two lower bolts (one on each side) from side of hull on outside. Insert the two small alining pins of special fixture (41-F-2997-200) in the holes. Attach a chain to the two towing clevises in front of vehicle. Back a wrecker up to front of vehicle, hitch winch cable to chain, and take up the slack. Remove all the bolts which secure power train to hull. Slack off winch cable until top of power train is tilted away from hull far enough for the fixture (41-F-2997-200) to be installed. Bolt lifting eye to center top edge of power train (fig. 124). Hitch wrecker boom cable to lifting eye, drive out alining pins, and carefully remove assembly. Guide assembly from inside vehicle to prevent damaging oil tubes (fig. 125).

126. TRANSMISSION AND FINAL DRIVE INSTALLATION.

a. Install Transmission and Final Drive Assembly (figs. 124 and 125). Place the two long spacer shims in position in each side

of the hull with sealing compound and insert two attaching bolts through the hull so the threaded ends of the bolts enter the shims far enough to prevent them from falling out of place. Apply sealing compound to other contacting surfaces. Attach removing and replacing fixture (41-F-2997-220), chain, and wrecker to the power train (fig. 125). Move the wrecker with the assembly suspended to the hull opening and aline the assembly with the hull. Back the wrecker slowly toward the hull, lowering the boom cable until the power train is tilted forward slightly at the top and carefully guide the lower side into the hull opening. Insert the two small alining pins of special fixture in the lower holes (one on each side), making sure the pins pass through the hull and the power train holes. Suspend the weight of the power train from the winch cable hitched to the towing clevises. Slack off the boom cable and remove the lifting eye. Tilt the power train back until the top edge is fitted into the hull. Insert the two large alining pins of special fixture through two holes along top edge of hull in order to aline the holes.

b. Install Attaching Bolts. Install bolts across top with nuts inside, and ream holes, if necessary, to make bolts fit. Remove alining pins. Install bolt at lower left end with head outside. Install the next upper three bolts with heads inside hull and nuts outside. Then install remaining bolts at left end from outside. Install remaining bolts at right end from outside of hull. Hold bolts or nuts on inside and tighten from outside. NOTE: *Install shorter bolts in two upper rear holes on right and left side, and a cap screw in hole just ahead of these.*

c. Connect Transmission to Attaching Units (fig. 123). Position steering brake control rod upper yokes to steering brake cross shaft lever and steering brake shaft lever. Insert yoke pins and cotter pins. Place stowage box in position at right of transmission, and install attaching cap screws. Screw transmission hull brace into boss at upper rear of transmission. Install hull brace attaching cap screws, and tighten lock nut at lower end of brace. Insert transmission filler through hull opening, and screw into filler neck. Install filler bracket attaching bolt and cap screw. Place hand throttle bracket and hand throttle in position on final drive, and install attaching cap screws. Insert and bend fuel priming lines around front of steering brake cross shaft, and connect lines to priming pump (par. 66 **d**). Connect transmission oil cooler lines to nipples on left side of transmission. Place horn switch wiring harness in position on right steering brake lever and install clips. Install switch attaching bolts to right steering brake lever. Place tachometer and speedometer cables in position on transmission, and install cable attaching clips. Screw knurled nuts to tachometer and speedometer adapters. Install bolts, nuts, and lock wire which secure front universal joint flange and generator drive

pulley to companion flange of transmission. Adjust generator drive belt tension (par. 88 c (2)). Install driver's floor plate. Install driver's seat (par. 148 c).

d. **Connect Tracks On Both Sides.**

e. **Install Front Sand Guards and Fenders.** Attach front fenders to power train housing and hull with lock washers, cap screws, bolts, and nuts. Attach front sand guards to center guard, front fenders, hull, and to final drive covers.

f. **Fill Power Train Lubrication System.** Open filler pipe cover on front of hull. Unscrew filler cap and pour 38 U. S. gallons of engine oil as indicated in paragraph 21, into transmission for single anchor, or 43 gallons for double anchor brake. Screw filler cap on tightly. Drive vehicle until oil temperature reaches at least 100° F. Stop vehicle on level surface, wait 5 minutes so that oil level can be measured accurately, and check with level indicator.

g. **Record Unit Replacement on W.D., A.G.O. Form No. 478.** If a new or rebuilt transmission and final drive assembly has been installed, make the proper entry on "MWO and Major Unit Assembly Replacement Record" (par. 2).

127. DIFFERENTIAL OR TRANSMISSION REPLACEMENT (POWER TRAIN ASSEMBLY OUT OF VEHICLE).

a. **General.** Whenever a new transmission is assembled to a differential carrier, the pinion gear must be removed and the proper amount of shims installed between pinion gear and pinion bearing of transmission. This is necessary to seat pinion at correct depth in teeth of differential ring gear. NOTE: *This operation is not necessary if a transmission is removed and then reinstalled to the same differential carrier.*

b. **Remove Final Drives** (par. 129 a). NOTE: *Omit this step for transmission replacement.*

c. **Remove Transmission from Differential.** Thread transmission lifting eye bolts (41-B-1586-350) into bosses on top of transmission case. Loop a chain through the eye bolts and take up slack with a hoist. Disconnect oil line at transmission and differential case Remove stud nuts which secure transmission to differential case, and lift off transmission. Remove rubber gasket.

d. **Remove Transmission Pinion Gear** (fig. 126). Remove cotter pin from end of pinion shaft (fig. 130). Remove pinion shaft nut (fig. 130), and lift out pinion shaft washer. Remove pinion gear with small pry bar. Lift off shims and spacer.

e. **Determine Required Thickness of Shims Between Pinion and Pinion Bearing.** The following dimensions must be obtained to determine the number of shims required.

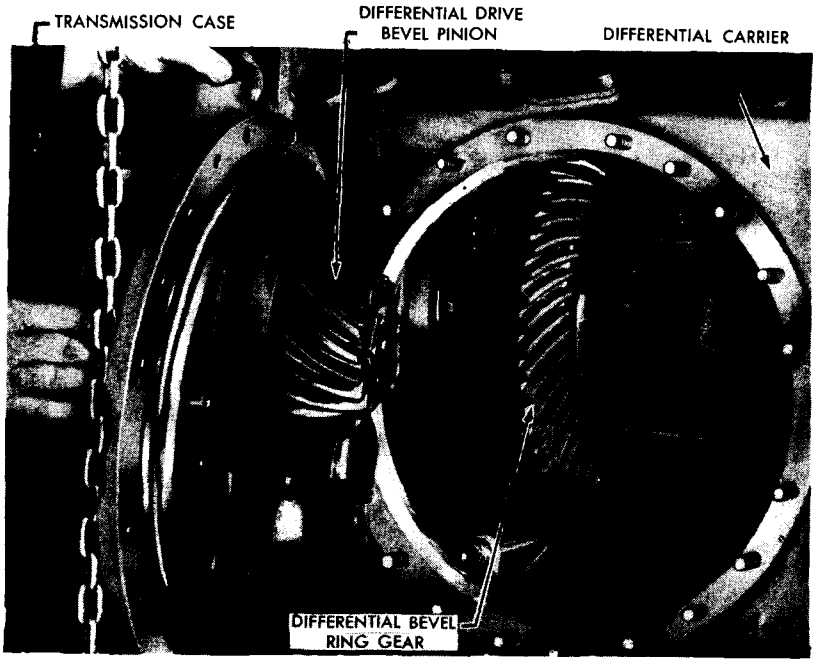


Figure 126 — Removing Transmission From Differential

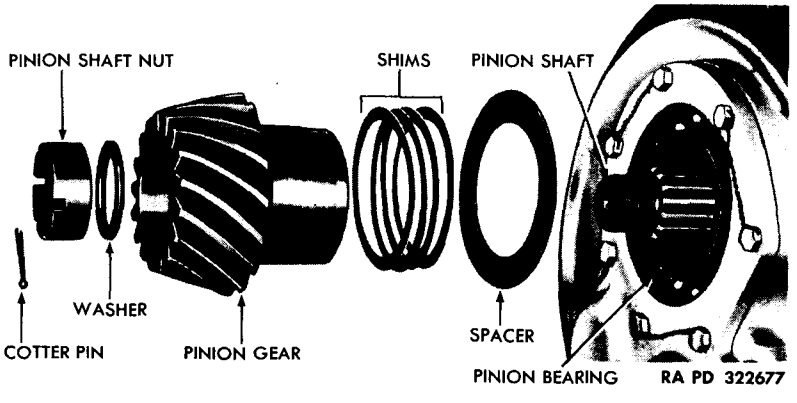


Figure 127 — Pinion Gear Removed From Transmission

(1) CENTER LINE OF CARRIER TO TRANSMISSION MOUNTING FLANGE. This dimension is normally 12 inches. Each carrier will

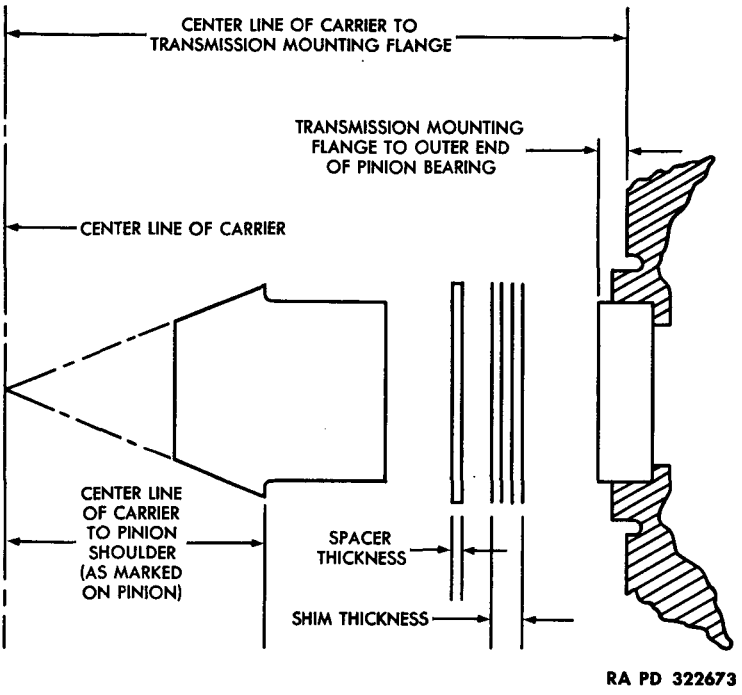


Figure 128 — Instruction Drawing For Determining Shim Thickness Between Transmission Pinions And Pinion Bearing

have a figure stamped somewhere on the machined surface to which the transmission is attached (fig. 129). This figure may be a decimal figure with a plus or minus sign, in which case it must be added to or subtracted from the nominal figure (12 inches). Some carriers will be marked with the actual dimension. For example: 12.005.

(2) CENTER LINE OF CARRIER TO PINION SHOULDER. Dimension is marked on toe of pinion with an electric pencil (fig. 130).

(3) SPACER THICKNESS. Measure spacer thickness with a micrometer. (Usually measures 0.020 inch.)

(4) TRANSMISSION MOUNTING FLANGE TO OUTER END OF PINION BEARING. This dimension is to be stamped on transmission case (fig. 130) just above pinion bearing bore. NOTE: *Figures ranging from 1.012 to 1.052 are stamped on some transmission cases. Such a figure indicates an early model transmission, and cannot be used for computation of required shim thickness.* If the transmission case is not stamped, if the figure is not legible, or if the transmission is an early type, the correct dimension is obtained as follows:

(a) Hold the short legs of the shim checking gage (41-G-217-150) firmly against the outer face of the inner bearing race (fig. 131). Using a feeler gage, measure the space between the long leg of the gage and the transmission mounting flange. *Add* the thickness of the feeler gage to the dimension etched on the side of the gage (1.773).

(b) In some instances the feeler gage will have to be used between the short legs of the gage and the inner bearing race. In this case, *subtract* the thickness of the feeler gage used from the dimension etched on the side of the gage (1.773).

(c) If a feeler gage cannot be inserted under either end of the gage, the dimension from the transmission mounting flange to the outer end of the bearing is 1.773 inches as etched on the side of the gage. CAUTION: *When using this gage, make certain that pinion bearing cap bolts are tight, holding pinion bearing securely in place.*

f. Final Computation. Example, showing method of determining required shim thickness:

Center line of carrier to transmission mounting flange (step (1) above and figure 129)	12.005 in.
–Transmission mounting flange to outer end of pinion bearing (step (4) above and figure 130)	1.767 in.
	=10.238 in.
Center line of carrier to pinion shoulder (step (2) above and figure 130)	10.163 in.
+Spacer thickness (step (3) above)	0.020 in.
	=10.183 in.
Difference of two sums 10.238 – 10.183 = 0.055	
*Subtract extra clearance allowance	0.005
Shim thickness required	0.050 in.

*This extra clearance value is constant and is 0.005 in any problem.

g. Install Transmission Pinion Gear. Slide required number of shims and spacer over heel of pinion gear. Tap pinion into bearing, using a rawhide hammer on toe of pinion. Install washer, pinion, shaft nut, and cotter pin (fig. 127). Spread cotter pin at center (fig. 130).

h. Install Transmission to Differential. Position rubber gasket around transmission mounting flange. Lift transmission into position against differential case. CAUTION: *Pinion and ring gear must be meshed carefully. Hard bumping is likely to damage gear teeth.* Install and tighten stud nuts. Connect oil line to fitting on transmission and differential case.

i. Install Final Drives (par. 129 b).

TRANSMISSION AND FINAL DRIVE ASSEMBLY

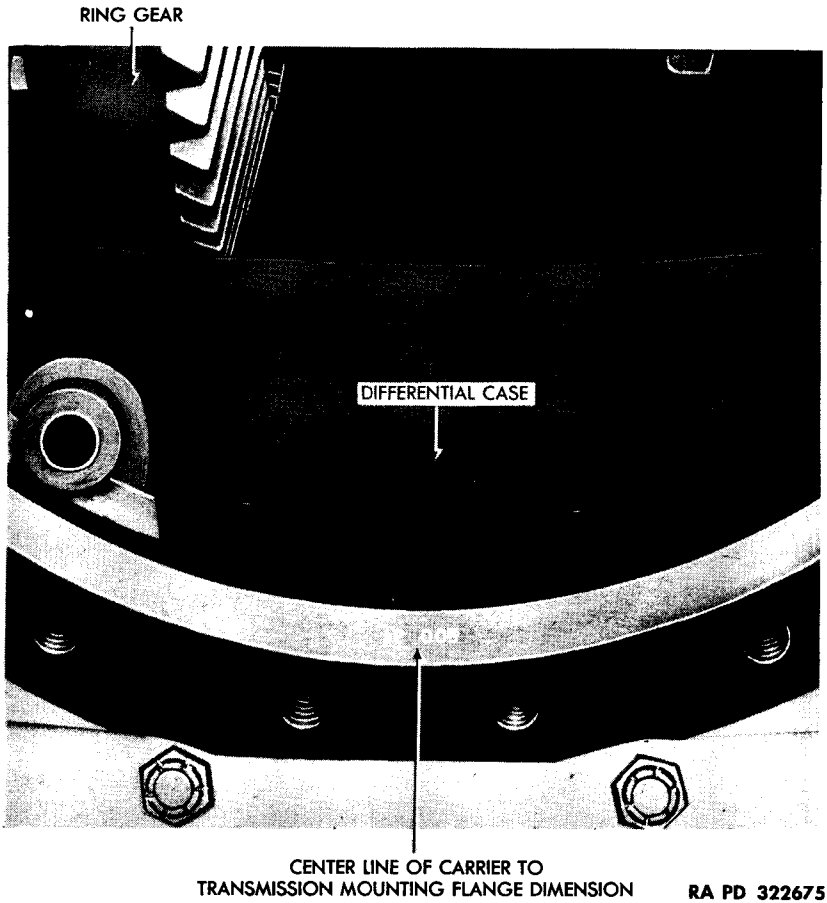


Figure 129 — Dimension Marking On Differential Case

128. TRANSMISSION OIL COOLER.

a. **Description** (fig. 6). The transmission oil cooler is mounted on the crew compartment side of the bulkhead to the right of the propeller shaft. The oil in the transmission, differential, and final drives is circulated through lines to the oil cooler by means of an oil pump built into the transmission. The oil enters at the bottom of the cooler and flows upward through a by-pass tube to the outlet connection at the top of the cooler, then returns through a tube to left side of transmission. When oil reaches a temperature of 100° F, the by-pass valve closes; this causes oil to flow upward through oil cooler tubes. Air drawn through cooler by engine fan reduces temperature of oil; then it is returned to final drive assembly to lubricate gears in transmission, differential, and final reduction assemblies.

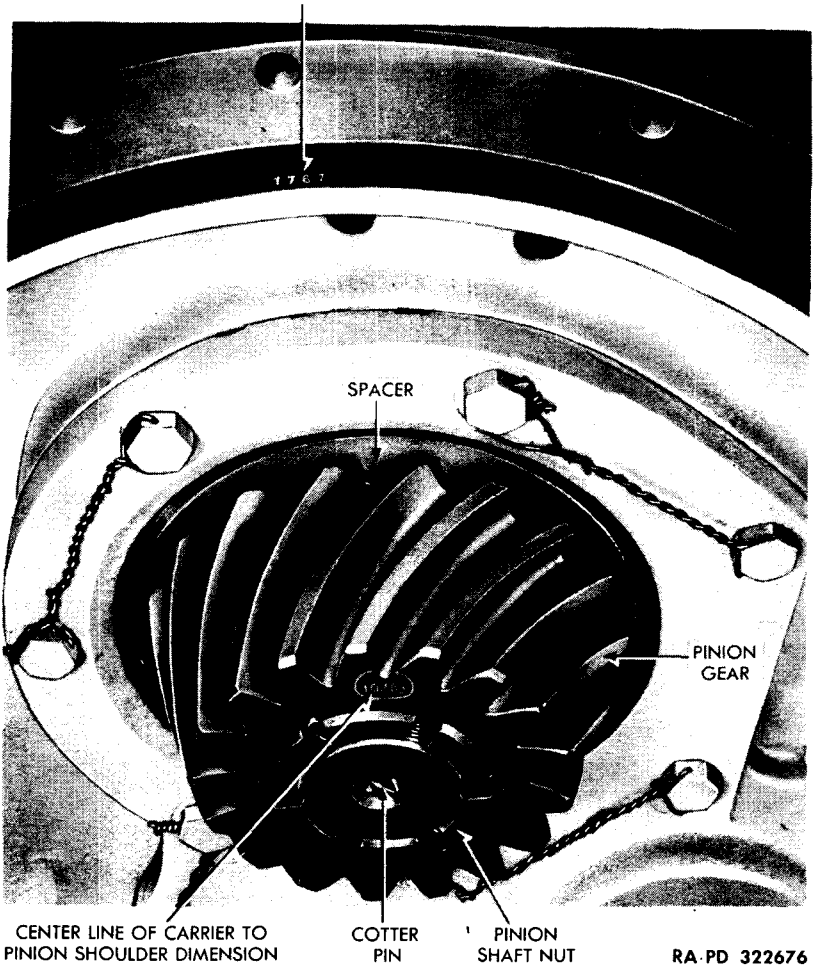


Figure 130 — Dimension Markings on Pinion and Transmission Case

b. Removal. Drain transmission and final drive assembly (par. 125 b). Remove rear section of crew compartment subfloor in front of cooler. Disconnect inlet and outlet line from top and bottom of cooler. Remove cooler guard attaching screws, and lift off guard. Remove cooler attaching bolts at each corner, and lift out cooler.

c. Installation. Position cooler on bulkhead, and install attaching bolts and nuts. Place cooler guard in position over cooler, and install cap screws. Screw oil tube connectors into top and bottom



Figure 131 — Using Transmission To Differential Shim Checking Gage (41-G-217-150)

connections of cooler. Install the subfloor. Fill transmission and final drive with lubricant (par. 126 f). Operate engine with clutch engaged, and inspect cooler and connections for leaks.

129. FINAL DRIVES.

a. Removal. Remove the two plugs from bottom of final drive housing and drain the oil. Disconnect track (par. 134 a). Remove drive sprocket and hub (par. 130 b). Support final drive assembly with hoist or by other means, and remove the cap screws which attach cover to final drive housing. Use a small pinch bar to pry unit away from housing, and continue to manipulate unit until it is free of the compensating shaft splines (fig. 132).

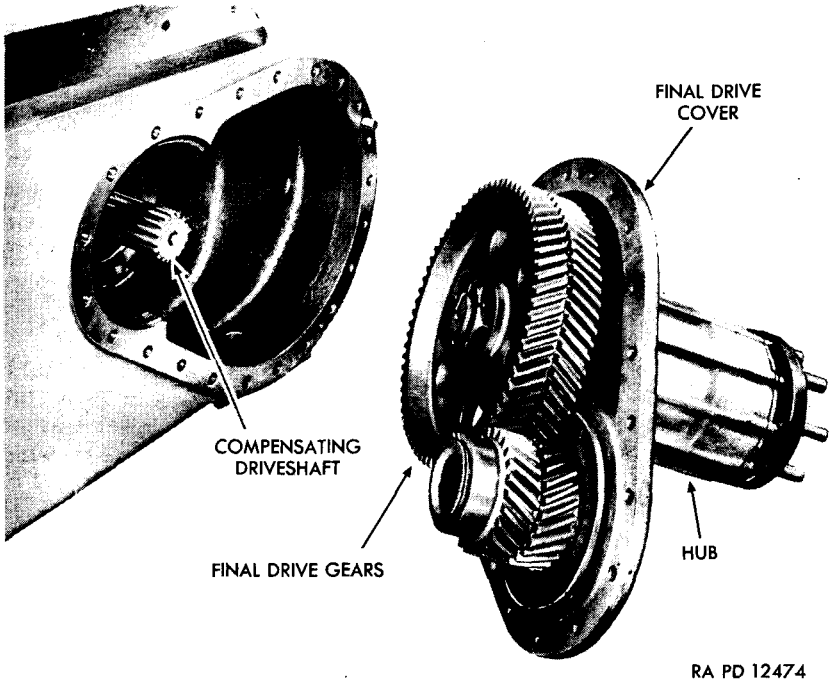


Figure 132 — Final Reduction Assembly Removed

b. Installation.

(1) POSITION FINAL REDUCTION ASSEMBLY. Remove all traces of torn gaskets from mounting faces of final drive cover and housing, and cover surfaces with sealing compound. Position gasket on housing and aline all the holes. Lift final reduction assembly into place with a hoist or by other means, and assemble to the final drive housing, rotating final drive shaft slowly to right and left until compensating pinion meshes on compensating shaft splines. Slide assembly into place over locating dowels.

(2) INSTALL ATTACHING CAP SCREWS. Install all cap screws and lock washers except the three for front fender directly over center of final drive cover. Tighten evenly around unit. Fill final drive assembly with lubricant.

(3) INSTALL DRIVE SPROCKET AND HUB ASSEMBLY. Refer to paragraph 130 **c**.

(4) CONNECT TRACK. Refer to paragraph 134 **b**.

(5) ADJUST TRACK TENSION. Refer to paragraph 134 **d**.

(6) RECORD UNIT REPLACEMENT IN W.D., A.G.O. FORM NO. 478. If a new or rebuilt final drive assembly has been installed,

make the proper entry on "MWO and Major Unit Assembly Replacement Record" (par. 2).

130. DRIVE SPROCKETS AND HUBS.

a. Description. Each drive sprocket assembly is made up of two sprockets bolted to a hub. The hub is bolted to flanged end of final drive shaft flange. The sprockets and/or hubs are interchangeable and may be transposed from right to left final drive shafts when the teeth have been appreciably worn.

b. Removal.

(1) DISCONNECT TRACK. Refer to paragraph 134 **a.**

(2) REMOVE SPROCKET AND HUB ASSEMBLY. Remove nuts which attach hub to final drive shaft, and remove dowel washers. Drive off sprocket and hub assembly. Remove cap screws which attach sprockets to hub, and lift off sprockets.

c. Installation.

(1) INSTALL SPROCKET AND HUB ASSEMBLY. Position sprocket (G-104-04-01960) on hub, aline holes, install cap screws (G-104-03-05835), and tighten. Lift sprocket and hub assembly into position on final drive shaft studs (G-104-04-01970). Install dowel washers (G-104-04-00550), and nuts, tightening nuts evenly around hub.

(2) CONNECT TRACK. Refer to paragraph 134 **b.**

(3) ADJUST TRACK TENSION. Refer to paragraph 134 **d.**

d. Maintenance. Inspect sprocket and hub assembly to make sure that sprocket and hub mounting cap screws are tight. If sprocket cap screws cannot be kept tight, replace them with self-locking bolts (A246629). Tighten these bolts to from 100 to 110 foot-pounds torque. When appreciable wear is noted on sprocket teeth, interchange right and left sprockets to bring track in contact with unused area of teeth.

131. GEARSHIFT LEVER.

a. Removal. Remove gearshift lever yoke bolt, fulcrum link bolt, and lever shaft. Then lift off gearshift lever.

b. Installation (fig. 133). Wipe surface of shaft clean, and cover bearing surfaces, bolts, and shafts with engine oil. Position lever on left side of transmission, install gearshift lever shaft, fulcrum link bolt, and fulcrum yoke bolt. Push shaft in and screw nut on inner end of shaft. Apply lubricant gun to lubrication fitting, and move gearshift lever back and forth while forcing lubricant into fitting. Tighten nuts so that linkage moves freely without excessive play, and insert cotter pins.

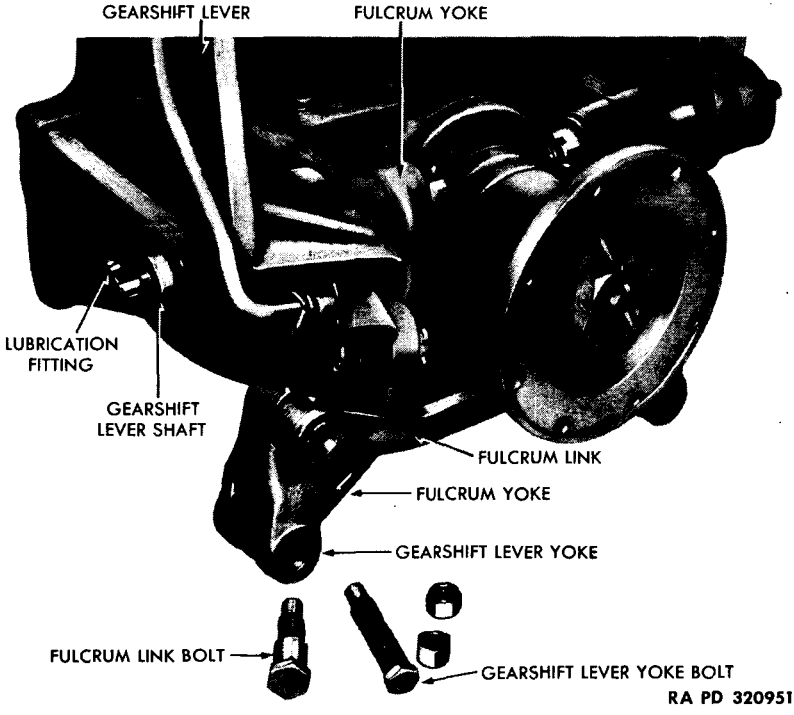


Figure 133 — Installing Gear Shift Lever

132. TACHOMETER AND SPEEDOMETER ADAPTERS.

a. Tachometer Adapter Removal (fig. 68). Back off cable housing retaining nut, and pull cable out of adapter. Back off hex nut at bottom of adapter, and lift adapter off sleeve. Straighten ears of lock washer under sleeve, and back sleeve out of transmission case. Lift tachometer drive shaft out of seal in transmission case.

b. Tachometer Adapter Installation (fig. 68). Install drive shaft. Position lock washer over opening in transmission case, and install sleeve. Bend one ear of lock washer over hex on sleeve and the other ear over edge of transmission case. Attach adapter to sleeve with hex nut at bottom of adapter. Insert tachometer cable into adapter, and secure cable housing to adapter.

c. Speedometer Adapter Removal (fig. 68). Back off cable housing retaining nut, and pull cable out of adapter. Back off hex nut at bottom of adapter, and lift adapter off drive extension shaft sleeve. Lift drive extension shaft out of sleeve. Back drive extension shaft sleeve out of driven gear sleeve. Remove two cap screws and lock washers which attach driven gear sleeve to transmission

case, and lift off sleeve and gasket. Lift speedometer driven gear out of seat in transmission case.

d. Speedometer Adapter Installation (fig. 68). Install speedometer driven gear. Position gasket and attach driven gear sleeve to transmission case with two lock washers and cap screws. Thread drive extension shaft sleeve on driven gear sleeve. Attach adapter to sleeve with hex nut at bottom of adapter. Insert cable into adapter, and secure cable housing to adapter with housing retaining nut.

Section XXVII

VERTICAL VOLUTE SPRING SUSPENSION

133. DESCRIPTION.

a. Two individually driven tracks propel the vehicle forward and backward (fig. 134). The vehicle is supported on six suspension assemblies bolted to the hull. Each suspension has two rubber-tired wheels. As the vehicle passes over uneven ground the vertical movement of the suspension wheels is transferred to the supporting arms or levers and is absorbed by the two volute springs in each suspension assembly. Two drive sprockets at the front end of the vehicle pull the tracks from the rear and lay them down in front of the advancing suspension wheels. A track skid and a single steel roller are mounted at the top of each suspension to support and carry the upper portion of the track. An adjustable idler wheel for each track is mounted at the rear of the vehicle for adjusting the tension of the tracks.

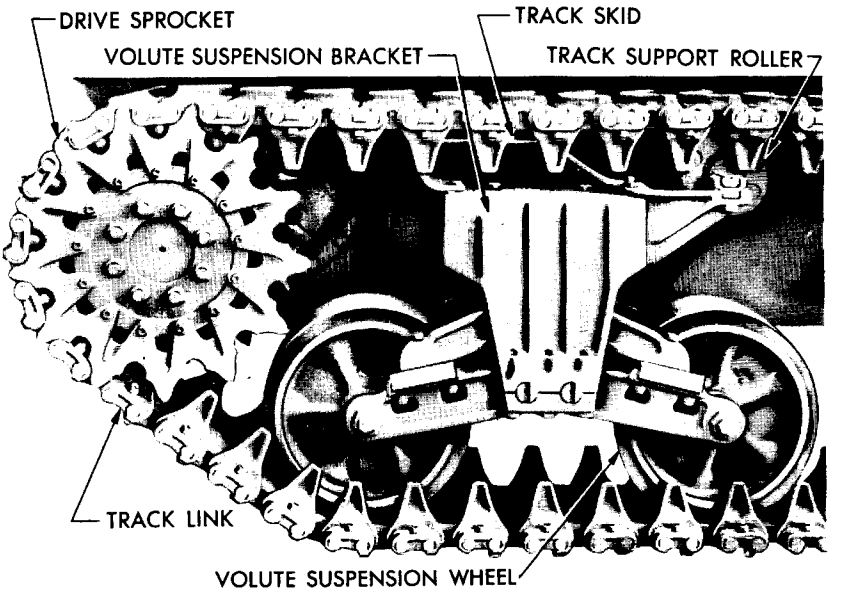
134. TRACKS.

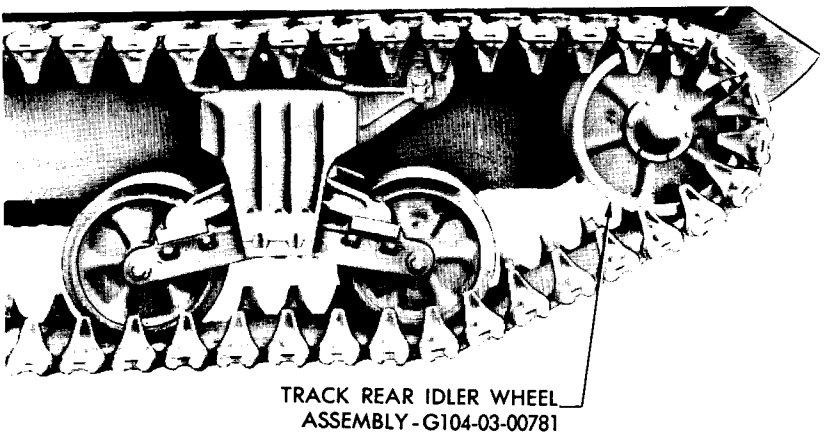
a. **Removal** (fig. 135). With vehicle on level terrain, so that it can be moved as required, remove track sand shields by releasing bayonet-type fasteners. Release track tension at idler adjustment (subpar. d (1) below). Break track between front suspension wheel and sprocket. NOTE: *If track has been thrown, break track underneath either idler or sprocket, depending on which end of track has the least twist.* Remove wedge nuts and wedges, and pull out connectors with track connecting fixture (41-F-2997-86). Lay top half of track on ground to rear of vehicle.

b. **Installation.**

(1) INSTALL TRACK (fig. 136). If a new track is to be installed, lay it in front of and in alinement with, the old track. If a thrown track is to be installed, dig a trench deep enough for end of track, so that suspension wheel can roll directly onto track. Tow vehicle onto

CARRIAGE, MOTOR, 105-MM HOWITZER, M7





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Figure 134 — Tracks and Suspension

VERTICAL VOLUTE SPRING SUSPENSION

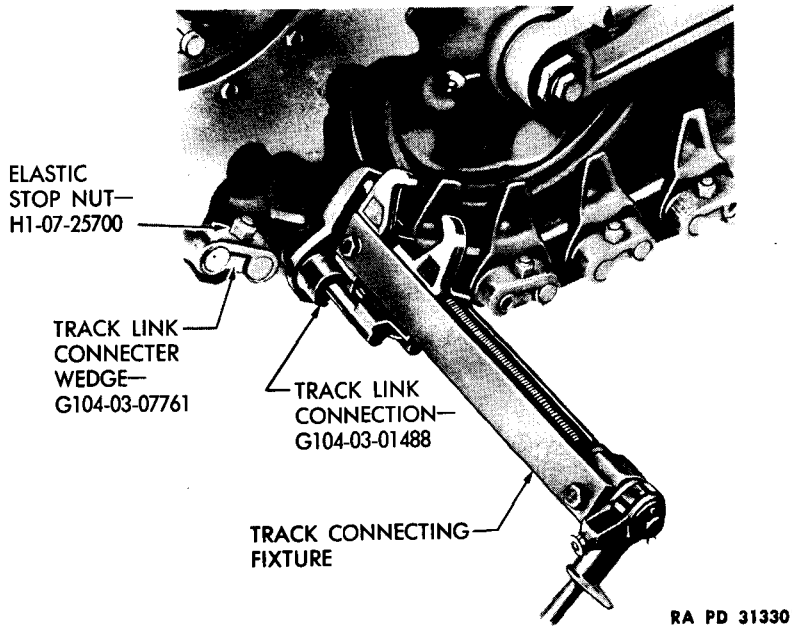


Figure 135 — Pulling Track Connectors

track until about 16 inches of end protrudes beyond front suspension wheel. Block suspension wheels in track to prevent vehicle moving. Place rear idler wheel in extreme forward position, and lock spindle in bracket to prevent breakage of idler bracket. Roll end of track over idler wheel, and pull track forward over support rollers and sprocket with cable attached to a towing unit.

(2) CONNECT TRACK (fig. 136). Attach track connecting fixtures (41-F-2997-86) to the ends of track, and draw ends together. Start the connectors (G104-03-01488) on pins in track blocks, and remove connecting fixtures. Drive connectors into place and install wedges (G104-03-07761), and nuts (H1-07-25700). Mark wedges which have been removed for final tightening. Move vehicle so that marked wedges are at idler wheel. Drive wedges in with a heavy hammer while tightening wedge nuts. CAUTION: *Never attempt to bring ends of track together by using hand crank or cranking motor to apply necessary force through power train. This will damage cranking motor gear train, or deflect the crankshaft.*

(3) ADJUST TRACK TENSION. Refer to subparagraph d below.

c. Replacement of Track Block (fig. 135).

(1) REMOVE TRACK BLOCK. Move vehicle so that shoe to be replaced is midway between idler wheel and rear suspension wheel.

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

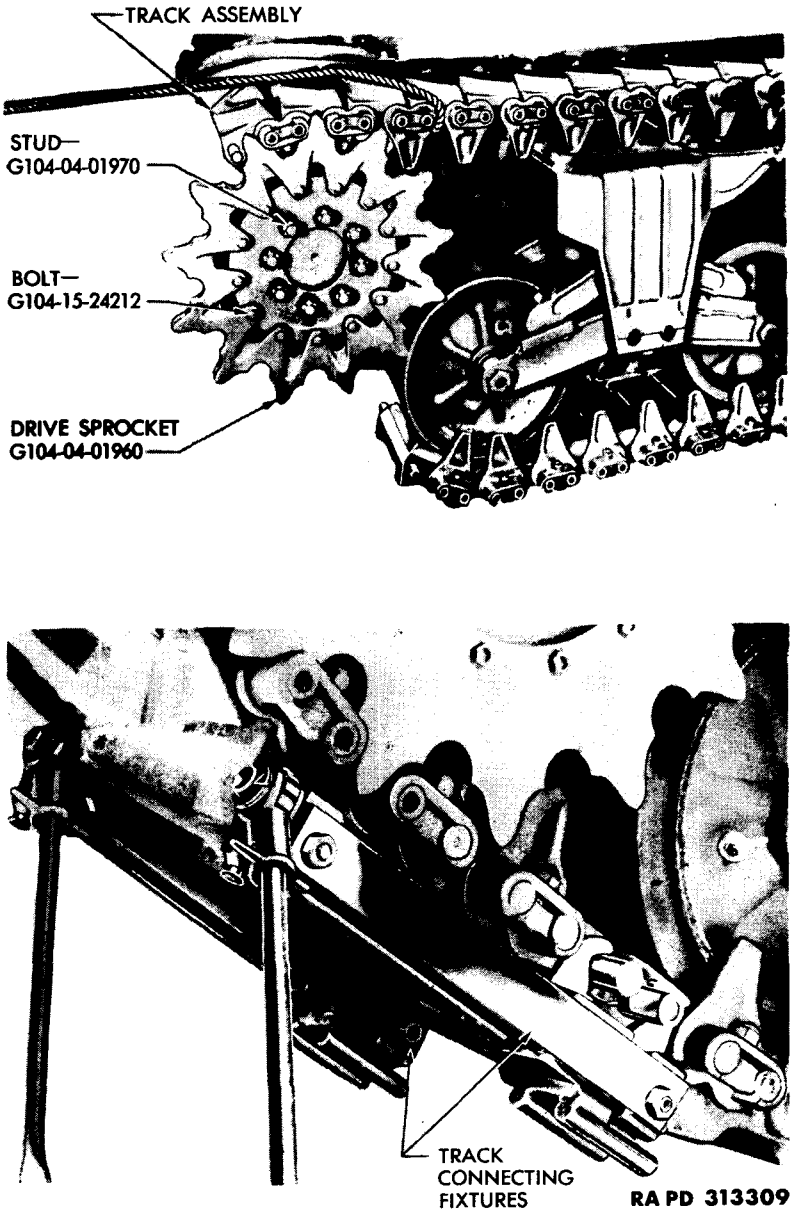


Figure 136 — Connecting Track With Fixtures (41-F-2997-86)

VERTICAL VOLUTE SPRING SUSPENSION

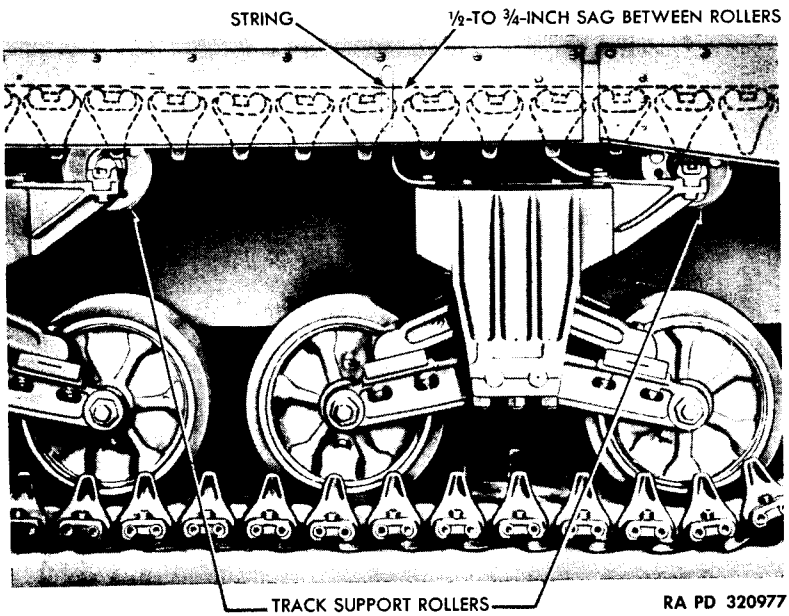


Figure 137 — Track Tension Adjustment

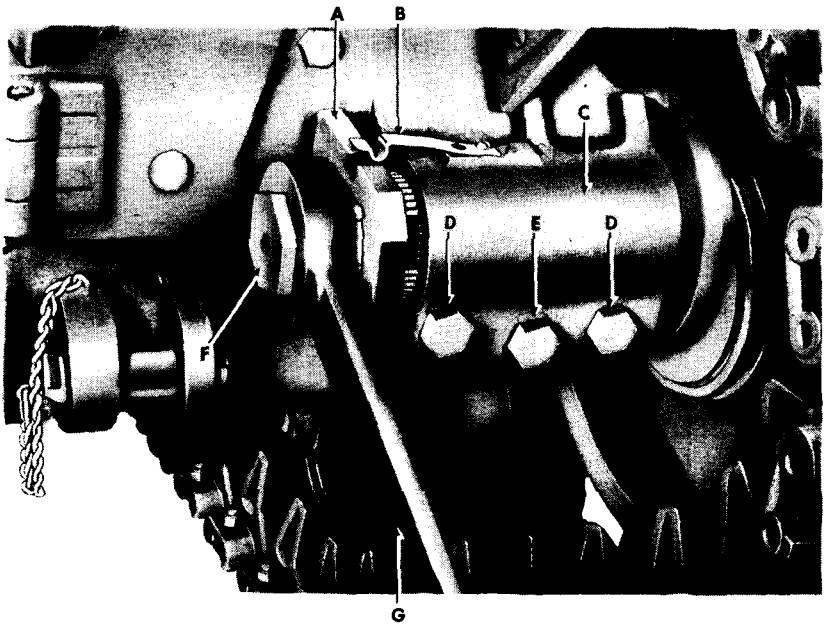
Release track tension at idler adjustment. Remove wedge nuts and wedges, and pull off connectors.

(2) INSTALL TRACK BLOCK. Attach new shoe to one end of track. Connect track shoes with track connecting fixtures. Install connectors, wedges, and wedge nuts. A new track block placed in a worn track will protrude beyond the adjacent blocks. This will cause excessive wear and early track failure. If possible, replace defective rubber track blocks with used blocks in good condition showing approximately the same wear as the track. If no worn blocks are available, cut tread side of new blocks to approximate height of adjoining rubber blocks.

(3) ADJUST TRACK TENSION AND LOCK IDLER ADJUSTMENT. Refer to subparagraph **d** below.

d. Adjustment of Track Tension.

(1) RELEASE IDLER LOCK (fig. 138). Loosen the two outside clamping bolts in idler wheel bracket with wrench (41-W-3058-480). Turn center bolt counterclockwise to spread bracket until spindle is free. CAUTION: *Excessive spreading will crack the bracket.* Place adjusting wrench on hexagon at end of spindle, and turn spindle to release bind on collar. Raise spring at end of bracket, and slide collar off serrations on idler wheel spindle.



A—ADJUSTING COLLAR
B—SPRING
C—IDLER WHEEL BRACKET
D—CLAMPING BOLTS
E—SPREADING BOLT
F—REAR IDLER WHEEL SPINDLE
G—WRENCH-(41-W-3058-480)
RA PD 320904

Figure 138 — Adjusting Track Tension, Using Wrench (41-W-2574-300)

(2) ADJUST TENSION (figs. 137 and 138). Stretch a piece of string along top of track between center and rear track supporting rollers. Use a piece of pipe on handle of adjusting wrench for leverage, and raise handle of wrench to tighten track until there is ½- to ¾-inch clearance between string and top of track, midway between center and rear track supporting rollers, when viewed through inspection slot in sand shield. Slide collar plate on and off spindle when changing the wrench position.

(3) LOCK IDLER ADJUSTMENT (fig. 138). Slide collar on serrations of spindle and lock it in place with the spring. Turn center spreader bolt clockwise until it does not project through slit in bracket. Tighten both outside clamping bolts securely, then tighten center spreader bolt until it binds sufficiently to hold it from working loose. Remove adjusting wrench.

(4) IDLER WHEEL ECCENTRIC SHAFT POSITION. Some vehicles may have idler wheel eccentric shaft set in the upper arc, or high position, which is incorrect. To facilitate track adjustment, the eccentric shaft should be reset in the lower arc, or low position, to allow

track adjusting wrench to be pulled up with a chain hoist, or pushed up with a jack. Reset eccentric shaft at time of track adjustment.

135. IDLER WHEELS AND BRACKETS.

a. Removal and Disassembly (fig. 139).

(1) REMOVE TRACK. Refer to paragraph 134 a.

(2) REMOVE THE IDLER WHEEL. Remove cap screws in idler wheel cap. Take out cotter pin which secures wheel nut, and remove nut and washer. Pull idler wheel (G-104-03-00781) off spindle with idler wheel puller (41-P-2940-800).

(3) REMOVE OIL RETAINERS AND BEARING. Remove outer idler wheel bearing and oil retainer. Remove center bearing spacer. Drift out inner idler wheel bearing and oil retainer.

(4) CLEAN AND INSPECT PARTS. Clean hub of idler wheel, bearings, and spacer. Inspect bearings carefully for rough or broken balls or cracked races. The bearing should spin freely without binding. Replace all damaged parts.

b. Assembly and Installation.

(1) INSTALL OIL RETAINERS AND BEARING. Pack inner idler wheel bearing with general purpose grease, and position bearing in hub. Drive bearing into hub with bearing drift, until bearing seats against shoulder of hub. Turn idler wheel over, and install center bearing spacer. Pack outer bearing with general purpose grease, and drive bearing into place in hub with bearing drift. Install two new oil retainers on spindle with lips of retainers toward shoulder of spindle. Place two shims (made from an old retainer) between shoulder of spindle and oil retainer to force oil retainer to proper depth in hub when idler wheel is installed.

(2) INSTALL TRACK IDLER WHEEL. Place idler wheel on spindle. Screw idler wheel installing tool (41-T-3216-150) on spindle, and force idler wheel onto spindle. Remove installing tool. Remove locating shims between shoulder of spindle and oil retainer. Install washer and nut on spindle and tighten securely. Install cotter pin. Install idler wheel hub cap with gaskets (G-104-03-02310) and retaining screws.

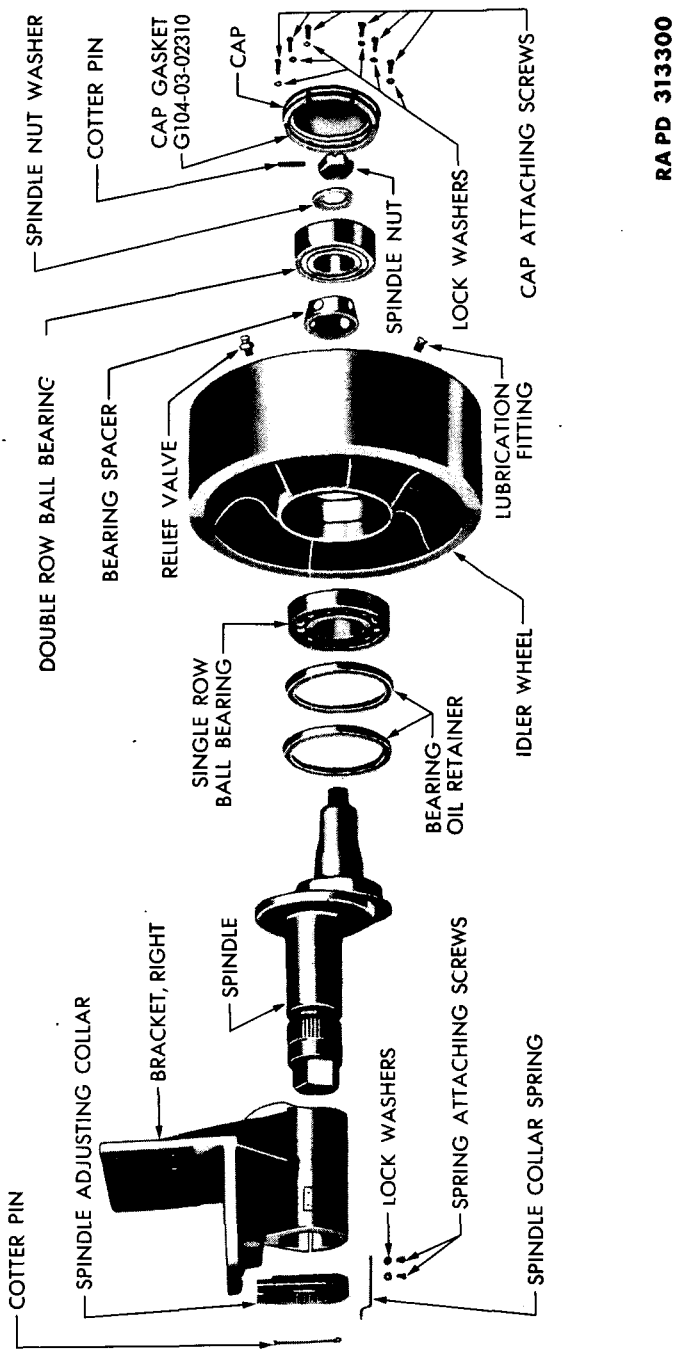
(3) INSTALL TRACK. Refer to paragraph 134 b.

(4) ADJUST TRACK TENSION. Refer to paragraph 134 d.

c. Removal of Idler Wheel Bracket.

(1) RELEASE IDLER LOCK. Refer to paragraph 134 d (1).

(2) DISCONNECT TRACKS AND REMOVE BRACKET. Disconnect track between idler wheel and rear suspension wheel. Remove sand shields, and move track toward front of vehicle until end of track is clear of idler wheel. Remove cotter pin from hexagon end of spindle,



RA PD 313300

Figure 139 — Idler Wheel Disassembled

and slide collar off spindle. Pull spindle and wheel out of idler wheel bracket. Remove cap screws that attach bracket to hull, and take off the bracket.

d. Installation of Idler Wheel Bracket.

(1) INSTALL BRACKET AND TRACK. Attach idler bracket to hull with cap screws. Tighten cap screws securely, and install lock wires. Spread bracket, and install spindle and wheel in idler wheel bracket. Slide collar on serrated end of spindle, and install cotter pin in hole in spindle. Pull track over idler wheel.

(2) CONNECT TRACK SHOES (par. 134 b (2)).

(3) ADJUST TRACK TENSION (par. 134 d (2)).

136. TRACK SUPPORTING ROLLERS AND BRACKETS.

a. Removal. Remove the lock wires and take out the cap screws that attach the track skid to the top of the suspension frame and remove the track skid. Place a jack between the track and the top of the suspension frame and raise the track sufficiently to take the weight off the roller. Remove the lock wires and take out the cap screws that attach the roller bracket to the suspension frame and remove the roller and bracket. Remove the lock wires and cap screws that attach the roller shaft to the bracket and lift roller and spacers from the bracket.

b. Installation. Place the roller (G-104-03-05690) and spacers in support bracket, and install the four cap screws that attach roller shaft to bracket. Tighten cap screws securely and install lock wires. Attach roller bracket to suspension frame with the six cap screws. Tighten cap screws securely and install lock wires. Remove the jack. Attach track skid (G-104-23-86584) to top of suspension frame with the four cap screws. Tighten cap screws securely and install lock wires.

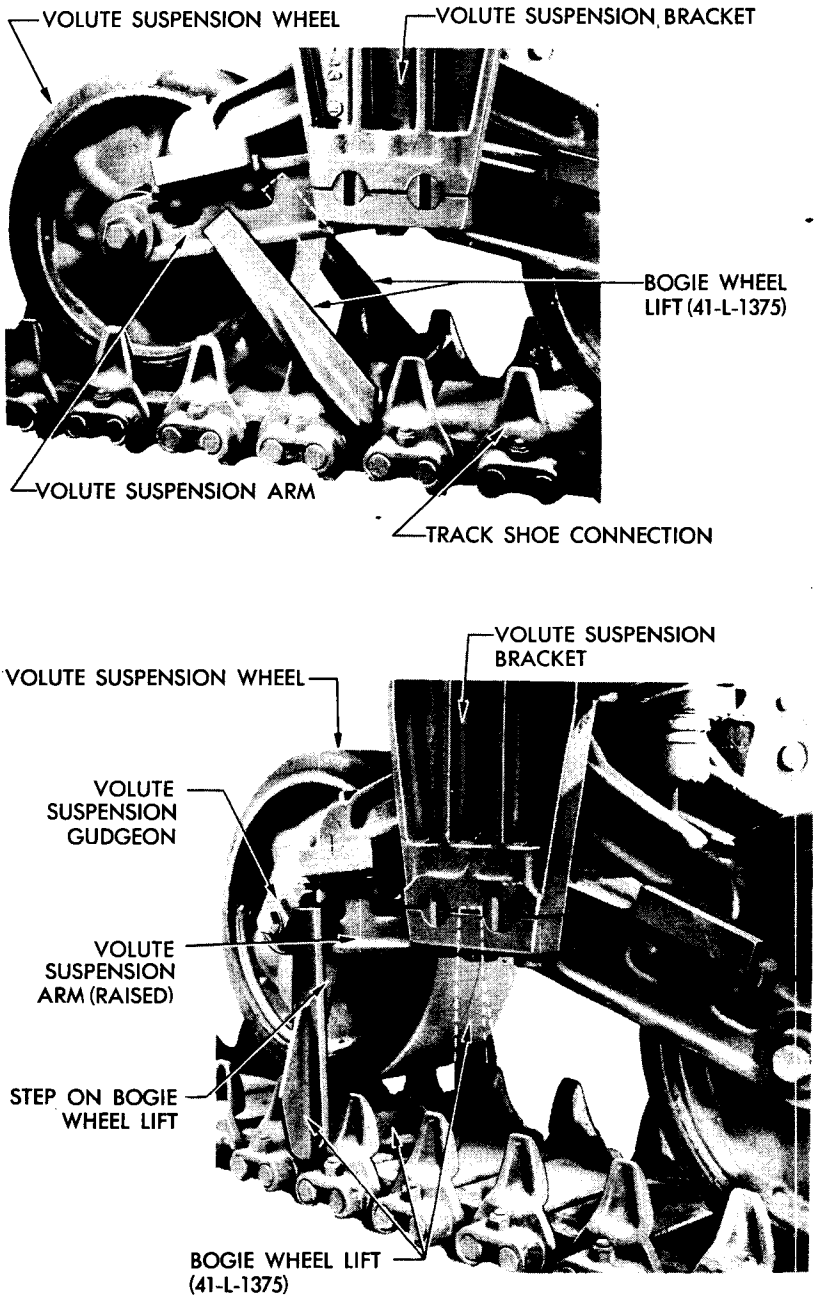
137. SUSPENSION WHEELS, BEARINGS, AND OIL RETAINERS.

a. General. The forward suspension wheel under drive sprocket on each track cannot be removed without disconnecting track. Remainder of suspension wheels can be removed without disconnecting track.

b. Removal and Disassembly.

(1) REMOVE SUSPENSION WHEEL (fig. 140). Place bogie lift (41-L-1375) on track under suspension arms to be lifted. Carefully drive vehicle forward or backward, depending on wheel to be lifted, until lift is vertical and wheel has been raised. If a forward wheel is being removed, release track tension, and break track between front

CARRIAGE, MOTOR, 105-MM HOWITZER, M7



RA PD 53605

Figure 140 — Raising Volute Suspension Wheel With Lift

suspension wheel and drive sprocket. Remove cotter pin from nut on inner end of wheel gudgeon, and remove nut. Remove plug in head of gudgeon pin. Screw gudgeon puller (41-P-2957-33) into the plug hole, pull out gudgeon pin, and remove wheel.

(2) REMOVE OIL RETAINERS AND BEARINGS (fig. 141). Support suspension wheel (G-104-18-46950) on its side on blocks. Move the bearing spacer located in center of hub between bearings, to one side. Use a drift seated on outer bearing race to drive out bearing, oil retainers, and outer spacer. Keep moving drift around entire circumference of outer bearing race, and drive bearing out evenly. Remove inner spacer, turn wheel over, and drive out other bearing, oil retainers, and outer spacer.

c. Assembly and Installation.

(1) INSTALL BEARINGS AND OIL RETAINERS (fig. 141). Lay the wheel on its side. Pack bearing with general purpose grease, and start inner bearing into hub by hand. Tap bearing into place with a drift until it seats against shoulder in hub. Install both inner and outer oil retainers on outer spacer with lips of retainers toward shoulder of spacer. Start spacer into wheel hub, and tap spacer into place with drift. Turn wheel over, and install inner spacer. Pack bearing with general purpose grease, and tap bearing into place in hub. Install oil retainer on outer spacer. Install spacer in wheel.

(2) INSTALL SUSPENSION WHEEL. Place wheel, with lubricant fitting out, on track between the arms. Aline gudgeon hole in arms and wheel. Install plug in hexagon end of gudgeon pin (G-104-22-05500), install gudgeon guide (41-G-2500), and start gudgeon pin through outer arms and into outer spacer and wheel bearing. Line up center spacer with a bar from inner side of wheel, and tap gudgeon pin into center spacer. Drive gudgeon pin through far enough to aline key slot in gudgeon with slot in outer arm. Install key, and drive the gudgeon pin all the way in. Install and tighten nut (G-104-23-15900) on inner end of gudgeon pin with a wrench, and secure with a cotter pin.

138. VOLUTE SPRINGS AND BRACKETS.

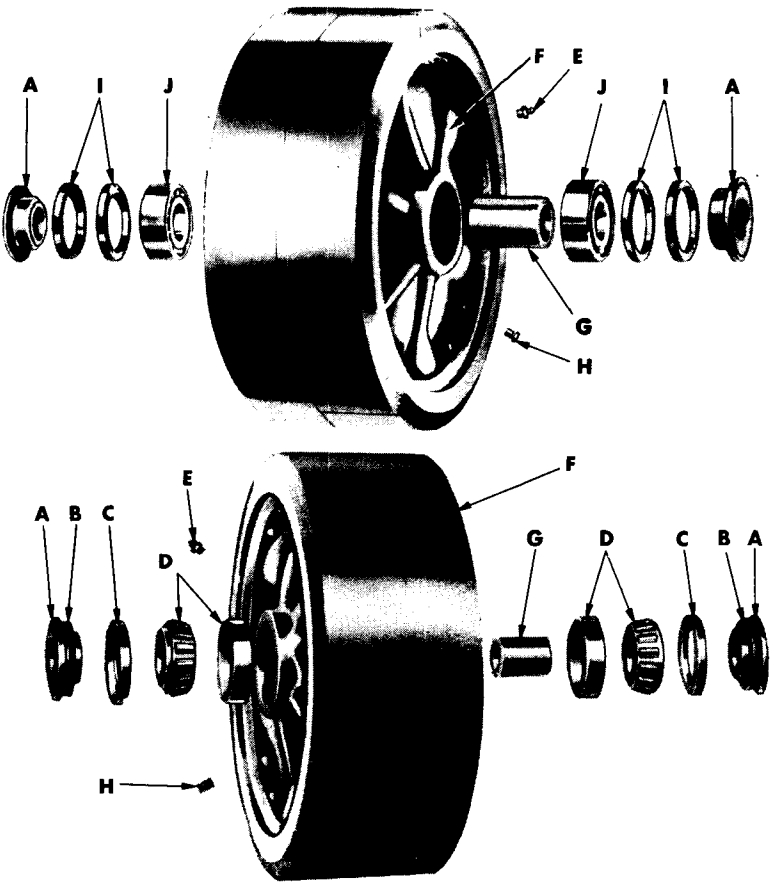
a. Removal and Assembly (fig. 142).

(1) RELEASE TRACK TENSION. Refer to paragraph 134 **d** (1).

(2) DISCONNECT TRACK. Break track between idler wheel and rear suspension wheel. Remove sand shields. Drive vehicle forward until end of top of track clears suspension to be removed. Set parking brake to prevent track moving.

(3) REMOVE VOLUTE SUSPENSION ASSEMBLY. Remove all cap screws from volute suspension bracket. Jack up vehicle hull so that suspension wheel will clear track. Lift out assembly with a hoist.

CARRIAGE, MOTOR, 105-MM HOWITZER, M7



A—BEARING SPACER, OUTER

B—BEARING OIL SEAL

C—BEARING OIL SEAL BACKING PLATE

D—ROLLER BEARING AND RACE

E—LUBRICATION FITTING

F—WHEEL AND TIRE ASSEMBLY

G—BEARING SPACER, CENTER

H—RELIEF FITTING

I—BEARING OIL RETAINER

J—DOUBLE ROW BALL BEARING

RA PD 53657

Figure 141 — Volute Suspension Wheel Disassembled

VERTICAL VOLUTE SPRING SUSPENSION

b. Installation of Assembly.

(1) INSTALL VOLUTE SUSPENSION ASSEMBLY. Lift assembly into track with a hoist. Place a jack under vehicle hull and lift side of vehicle sufficiently to allow foot of bracket of the suspension assembly to clear bottom of hull. Lower the hoist and move top of assembly into position against hull. Line up mounting holes, and install cap screws or nuts.

(2) CONNECT TRACK. Drive vehicle backward, and guide track over rollers with a bar or plank into position to be connected. Connect track with track connecting fixture.

(3) ADJUST TRACK TENSION. Refer to paragraph 134 **d** (2).

c. Removal of Volute Springs.

(1) RELEASE TRACK TENSION. Refer to paragraph 134 **d** (1).

(2) DISCONNECT TRACK. Refer to paragraph 134 **a**.

(3) COMPRESS SPRINGS. Place a jack under hull of vehicle to maintain level of hull when springs are removed. Remove track skid. Remove two plugs in top of volute suspension bracket with wrench (41-W-1960). Insert the two volute spring compressors (41-C-2556) in holes, and screw them into spring seat tightly. Tighten spring compressor nuts against suspension, and draw up nuts evenly with wrench (41-W-640-200). Compress springs until levers are free at rubbing plates.

(4) REMOVE SPRINGS. Place a jack on track under two spacers between suspension arms to support the arms when gudgeon caps are removed. Bend ears of locks away from heads, remove cap screws holding gudgeon caps to volute suspension, and remove gudgeon caps. Lower the jack and remove the volute suspension plates. Then place jack under spring seat to support seat. CAUTION: *Keep a wrench on the hexagon at top of spring compressor when releasing the spring, to prevent unscrewing spring compressors from the spring seat.* Loosen nuts on compressors *evenly and a little at a time* while lowering the jack. When springs are *fully* released, remove jack. Remove spring compressors. The springs, spring seat, levers, and arms can then be lifted out. NOTE: *Three types of bogie spring seats are in use. Should seat (C95130) fail, replace it with latest type seat (C95289) on all but limited service vehicles.*

d. Installation of Volute Springs.

(1) INSTALL SPRING. Place the two spring compressors (41-C-2556) through the two openings in top of suspension bracket. Position springs, spring seat, and levers in suspension bracket and screw spring compressors into spring seat securely. Screw nuts on spring compressors against suspension bracket, and compress springs.

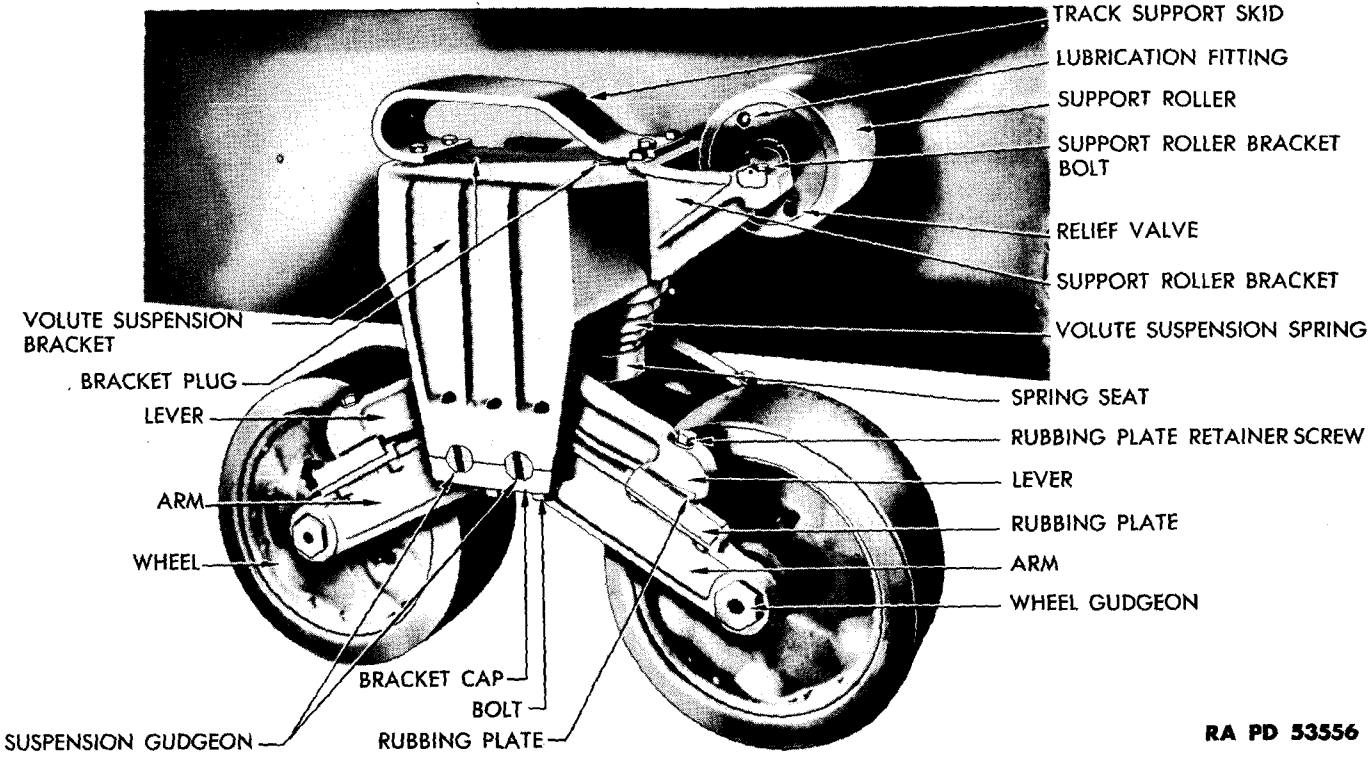


Figure 142 — Volute Spring Suspension Assembly

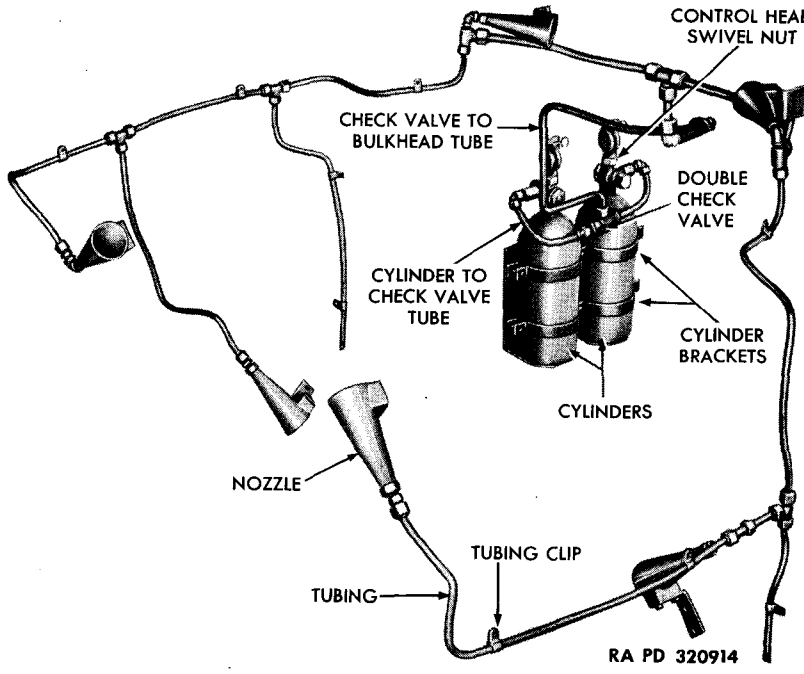


Figure 145 — Fixed Fire Extinguishing System

b. Installation (fig. 87). Open driver's door. Place windshield in position on outside of direct vision opening, and secure with spring clips at each corner on the inside. Connect wiper and defroster cable with outlet socket in instrument panel.

c. Removal. Disconnect wiper and defroster cable from outlet socket on instrument panel. Release spring clips at each corner, and remove windshield.

144. FIXED FIRE EXTINGUISHER SYSTEM.

a. Description and Data.

(1) DESCRIPTION. The two 10-pound fire extinguisher cylinders and the tubing and nozzles installed in the engine compartment and connected to the cylinders, are removable in individual units or sections. A double check valve installed in the tubing near the cylinders, allows cylinders to be operated individually.

(2) DATA.

Manufacturer ..... Walter Kidde & Co., Inc.

b. Removal of Fire Extinguisher Cylinders (figs. 145 and 11). Lift the fire extinguisher cover. Unscrew the control head swivel

nut; lift off the head and lay aside. Back off tube connector nut from cylinder, and loosen all connector nuts at check valve. Loosen cylinder bracket holding screws, and lift cylinder up and out of bracket. Remove other cylinder in same manner. CAUTION: *Do not drop, strike, or expose cylinder to unnecessary heat.*

c. Maintenance. Remove control head from cylinders, and weigh each cylinder to determine weight of carbon dioxide. The empty weight and the full weight are stamped on the valve of each cylinder as it stands without any attachments. Weigh the cylinder with contents. From this weight subtract empty weight to determine net weight. If the weight is less than 9 pounds, replace the cylinder with a fully charged one.

d. Installation of Fire Extinguisher Cylinders (figs. 145 and 11). Place the cylinder in brackets with outlet connector away from center of brackets. Loosely attach both ends of cylinder to check valve tube. Tighten cylinder holding clamp screws. Tighten cylinder tube connector nuts and double check valve connector nuts. Install control head (subpar. f below). Install other cylinder in same manner. Check all connections for tightness. Close the cover.

e. Removal of Control Head (fig. 145). Loosen control head swivel nut. Lift off head.

f. Installation and Adjustment of Control Head (fig. 145). Install control head loosely on cylinder. Turn shaft in center of control head so that pin in center shaft points straight up and down, to reset control head (fig. 11). CAUTION: *Pin in center shaft must be straight up and down to prevent discharging cylinder when head is installed.* Tighten connector nut.

g. Removal of Lines and Nozzles (fig. 145). Remove engine (par. 51). Remove left and right lower engine shroud seal attaching bolts and shroud attaching screws, and lift out shrouds. Remove nozzle bracket attaching schrews. Swing nozzle out on elbow, and unscrew nozzle from elbow or tube. Remove tube clip attaching screws. Unscrew tube coupling nuts from fittings, and lift out tube section and fittings.

h. Installation of Lines and Nozzles (fig. 145). Assemble tubing loosely in vehicle, but do not tighten coupling nuts on fittings. Screw nozzles on elbows and tubes. Install nozzle bracket attaching screws in hull. Install tube clips, toothed lock washers, and screws, making sure metal surfaces on each side of washers are clean and free of paint. Tighten connector nuts. Place right and left lower engine shroud and shroud seal in position. Install seal attaching bolts and shroud attaching screws. Install engine.

sides of canvas to hooks on hull around outside of fighting compartment.

b. Cover for 105-mm Howitzer.

(1) DESCRIPTION (fig. 4). A canvas cover which slides over end of howitzer tube and attaches to vehicle canvas top, is provided to enclose front of vehicle and cover forward part of howitzer.

(2) INSTALLATION. Slide opening in cover over end of howitzer tube. Attach upper part of cover to vehicle top with zipper fastening. Fasten straps along bottom of cover to loops on the hull directly above transmission oil filler cover.

c. Breech Cover for 105-mm Howitzer.

(1) DESCRIPTION (fig. 4). A cover for the 105-mm howitzer breechblock and the end of the cradle is provided to protect machined surfaces from dirt and moisture.

(2) INSTALLATION. Open all zipper openings in cover. Remove howitzer from traveling lock, and pull cover forward as far as possible to cover sight extension. Close zippers on both sides. Pull cover up over breechblock and fasten strap. Close zipper down middle of top.

d. Cover for Cal. .50 Machine Gun.

(1) DESCRIPTION (fig. 4). This cover completely encloses the cal. .50 machine gun while the gun is mounted on the traversing ring.

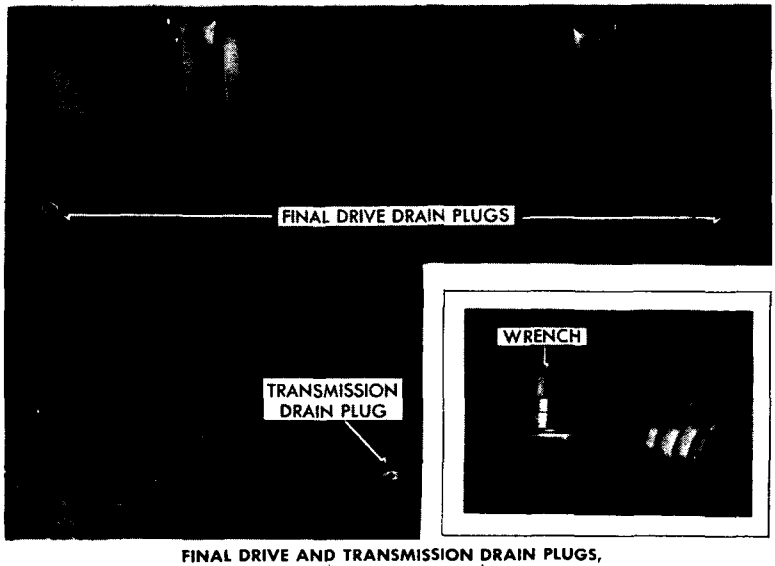
(2) INSTALLATION. With zipper opened, slide cover over front of machine gun. Loosen traveling lock, and pull cover on over gun the rest of the way, then close zipper. Put traveling lock in place and tighten.

e. Removal of Canvas Top and Covers. To remove vehicle canvas top or any of the covers, open all zipper fastenings and untie all straps. Lift off top or covers carefuly to avoid tearing canvas on sharp edges; fold and stow in proper stowage position. Do not fold canvas while wet. Remove top and side bows, and replace in stowage positions on right and left side of hull exterior.

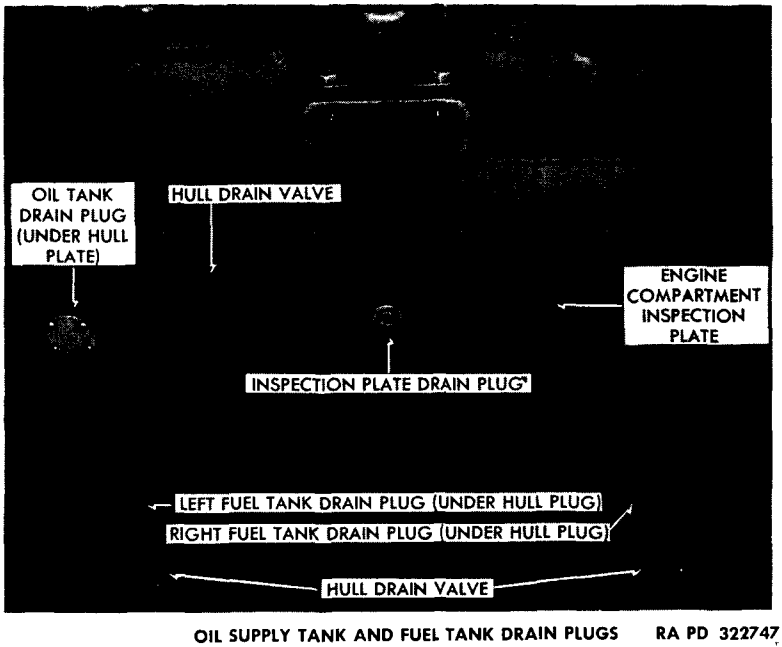
155. DRAIN VALVES.

a. Description. Drain valves are installed in hull floor in driver's compartment, beneath crew compartment floor plates and engine compartment floor. Drain valves, when closed, seal bottom of hull against entrance of water, and when open allow accumulated water to drain out of hull.

b. Removal. Tap cap retaining pin out of cap and valve stem. Lift off cap and spring. Push valve out of valve seat, then out through hull floor.



FINAL DRIVE AND TRANSMISSION DRAIN PLUGS, AND SPECIAL PLUG WRENCH (41-W-2622)



OIL SUPPLY TANK AND FUEL TANK DRAIN PLUGS RA PD 322747

Figure 149 — Hull Drain Valves, Plugs, and Openings

c. Installation. Insert valve into opening in hull floor and up into valve seat. Place spring over valve stem. Install cap and retaining pin.

Section XXIX

RADIO INTERFERENCE SUPPRESSION

156. INTRODUCTION.

a. Purpose. Radio interference suppression is the elimination or minimizing of the electrical disturbances which might interfere with radio reception, or which would disclose the location of the vehicle to sensitive electrical detectors. Because of the type of operation of these vehicles, many sources of interference are present and must be considered in order to maintain effective suppression. It is important that all vehicles, with or without radio equipment, be suppressed properly to prevent interference with radio-equipped vehicles.

b. Description. Suppression is accomplished in vehicles by the use of condensers, filters, shielding, and/or bonding in all circuits to confine and dissipate electrical disturbances that might affect radio reception. When any electrical circuit is interrupted, such as to stop or change the flow of current, frequencies which interfere with sensitive signal and detection apparatus are broadcast. The extent of this interference depends upon the amount of current flowing and the rapidity of change. The frequencies which are set up will radiate from or feed back into the circuit, causing the radio interference. Various types of suppression are used as described below to prevent such interference:

(1) FILTERS. Filters are generally constructed of a magnetic coil with two condensers connected in parallel. These units are sealed in a metal shielding, and connected in series with the circuit. This type of suppression is used in circuits where rapid interruption or changes of current occur, such as in the ignition or regulator circuits, to prevent a feed-back into the battery and to other circuits which are connected to the battery.

(2) CONDENSERS. A condenser, or capacitor (as sometimes called), is a storage space for electrical energy and functions similarly to a surge tank or diaphragm in a hydraulic circuit. The unit is constructed of two layers of a highly conductive flexible material, such as tinfoil, insulated from each other by a nonconductive material, usually a wax-impregnated paper. These components are rolled together so that a terminal can be attached to each end of the roll forming contact with the individual layers of foil. The unit is sealed in a metal container with one terminal connected to the container

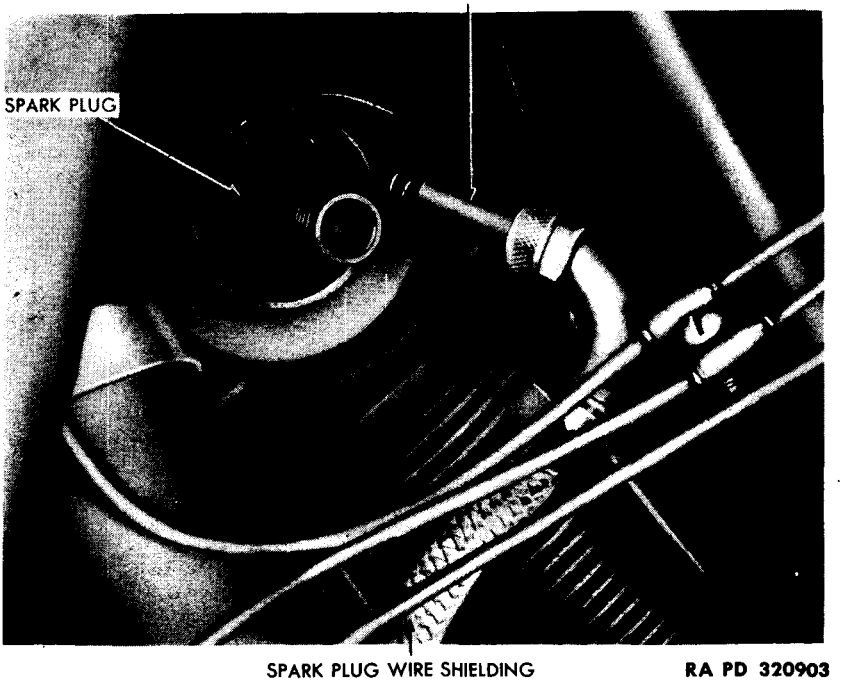


Figure 150 — Spark Plug Resistor Suppressor and Wire Shielding

and the other connected to an insulated lead for connection to the circuit. This type of suppression is used in parallel with the circuits which carry a high flow of current, such as in the generator armature, windshield wiper motor, and instrument panel outlet.

(3) SHIELDING. Shielding, such as conduits, fittings, enclosed terminal boxes and covers, is used to protect the wiring and to afford a conductive path for the radiated frequency to ground (vehicle structure). This type of suppression is used throughout these vehicles on all wiring and cables. In some instances, individual wires are covered with a metallic braid which is grounded to form a shield.

(4) BONDING. Bonding is a secure ground (conductive contact) to the vehicle structure. Wires, cables, copper braid, and plated clips or clamps are used for bonding purposes. These bond straps and clips or clamps are attached to a clean surface on the vehicle with plated screws and toothed lock washers. Where the greatest sources of interference are anticipated, the terminals of the bond straps or the flange of the clips are placed between two toothed lock washers and secured to the vehicle. All switch and terminal boxes are mounted with toothed washers against the mounting surfaces, as well

as under the screw or bolt head, and the covers are securely bonded to the boxes. All sand shields and fenders are securely bonded by the use of toothed lock washers in assembly. IMPORTANT: *All bonds must be securely restored when replacing any equipment treated for radio suppression.* The ground straps on the engine, regulators, and instrument panel are necessary to complete the electrical circuit for proper operation of the units. While these ground straps may be sufficiently tight for operation, they may present a source of radio interference if good contact is not insured.

157. IGNITION SYSTEM.

a. Description. When the engine is running the magneto points make and break contact rapidly to interrupt the primary circuit. This interruption causes the high tension circuit to discharge a spark at the spark plugs. Both of these conditions set up impulses or frequencies which could be radiated as radio interference. Suppression of this interference is accomplished as follows:

(1) MAGNETO. A condenser is used across the contact points in each magneto to prevent arcing and to intensify the high tension spark. The action of the condenser in performing its function also suppresses the radio interference impulses that would be caused by arcing.

(2) SPARK PLUGS AND WIRES (fig. 150). The spark plug wires are enclosed in flexible conduits which form a shield over the wires to dissipate interference. The terminals of the spark plug wires in contact with the spark plugs are fitted with resistor suppressors.

b. Replacement. The condensers in the magnetos are a part of the ignition circuit and not purposely intended for radio suppression. To eliminate interference from this source, replace the magnetos (pars. 54 and 55). To replace spark plug resistor suppressors proceed as follows: Open master switch. Loosen spark plug wiring harness connector nut from harness elbow. Back off elbow connector nut from spark plug. Pull out resistor suppressor. Straighten strands of wire which are bent over end of suppressor. Pull off suppressor. Place new suppressor over end of wire. Bend strands of wire back over resistor suppressor to clinch wire on suppressor. Insert suppressor in spark plug. Tighten elbow nut on spark plug, and tighten harness nut on elbow.

158. STARTING SYSTEM.

a. Description. The cranking motor, cable, solenoid, and cranking motor switch are shielded and grounded to eliminate interference. When the engine is cranked, a heavy flow of current is drawn over the cable and through the contacts of the solenoid. Suppression is

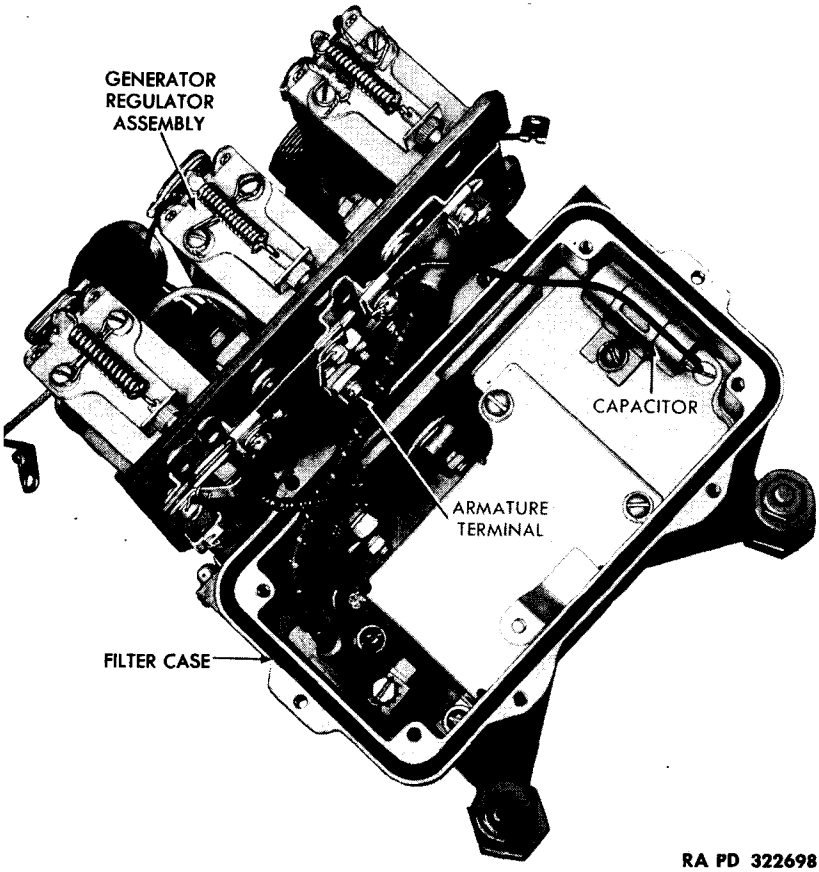


Figure 151 — Condenser or Capacitor in Generator Regulator Filter Case

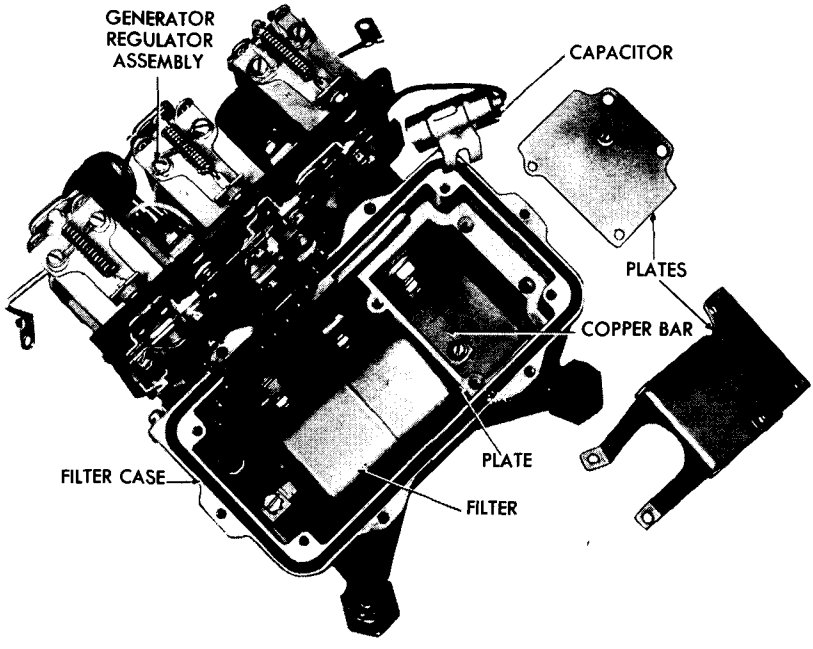
necessary to minimize the interference set up when the circuit is closed and opened, and when the cranking motor is operating.

b. Replacement. A bond strap connects the engine mounting to the hull to insure a good ground for the engine electrical units. Loose connections, burned commutator, or faulty brushes would cause radio interference. For information pertaining to replacement of components of the starting system, see paragraphs 84 and 85.

159. GENERATING SYSTEM.

a. Description. The generator and regulator are a constant source of radio interference because of the varying friction contact of the generator brushes on the commutator and the rapid action of the contact points in the regulators. Suppression is accomplished as follows:

RADIO INTERFERENCE SUPPRESSION



RA PD 322717

Figure 152 — Filter in Generator Regulator Filter Case

(1) GENERATOR. Two condensers (0.1 mfd), which are mounted inside the commutator end housing of the generator, are connected to the positive brushes to minimize the interference caused by worn or faulty brushes and commutator. A ground cable connects the generator to the hull to insure a good ground for the generator (fig. 67).

(2) REGULATORS. One FL19 filter and one condenser (0.5 mfd) are mounted in the regulator (figs. 151 and 152). A ground strap at each shock mount completes the electrical circuits of the regulator, as well as insuring a good electrical bond for the elimination of radio interference (fig. 68). The filter is connected in series with the battery lead, and the condenser is connected in parallel with the armature circuit.

b. Replacement.

(1) GENERATOR AND REGULATOR SUPPRESSION. The suppression equipment used in the generator and in the regulator is an integral part of the units. See paragraphs 88 and 89 for replacement of these units.

(2) BOND STRAPS (fig. 68). To remove any of the generator regulator bond straps, remove the hold-down studs below the mount-

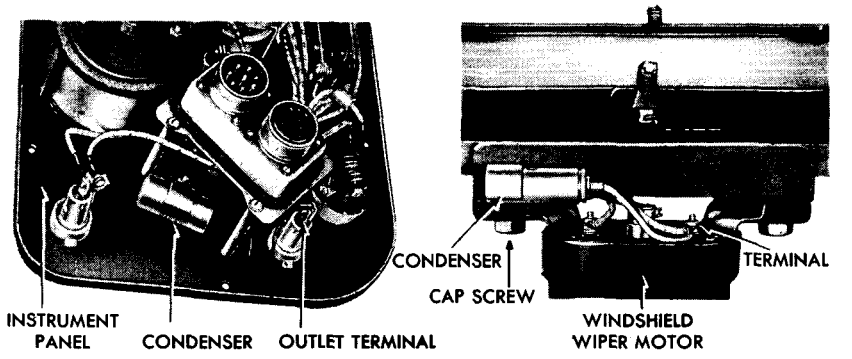


Figure 153 — Instrument Panel and Windshield Wiper Motor Condensers

ing bracket and lift the assembly sufficiently to release the bottom of the strap. Then remove the top stud nuts, and lift off the bond strap and toothed lock washer. To install, first clean the mounting bracket surface around the stud holes to insure good contact between bracket, washer, and strap. Position toothed lock washer over stud holes. Position bond strap on stud; then lower studs through mounting bracket, and install stud nuts. Position toothed lock washer and upper end of bond strap over top of stud, and install lock nut.

160. INSTRUMENTS.

a. Description. All instruments which are enclosed in the instrument box are bonded to and shielded by the box, which in turn is bonded to the sponson by a wire. The utility outlet, which is sometimes used to connect the windshield wiper for the driver's door windshield, is suppressed by a condenser (0.1 mfd) connected in parallel with the outlet inside the instrument panel (fig. 153). A condenser (0.1 mfd) is mounted in the windshield frame and connected from the wiper motor positive terminal to ground.

b. Replacement. Open master switch and remove the instrument panel cover mounting screws without disconnecting any of the cables or conduits from back of box. Pull top of panel out for access to wiring on back of panel. Disconnect condenser lead from utility outlet, and remove condenser mounting screw. To connect, attach new condenser with mounting screw and an external-toothed lock washer. Connect condenser lead to outlet terminal. Place panel in position and install panel screw. To replace windshield wiper motor capacitor, remove two wiper motor attaching screws and lock washers. Disconnect capacitor wire from positive terminal of wiper motor. Cut conduit shield from capacitor clamp. Solder new conduit shield

to capacitor clamp, and connect capacitor wire to positive wiper motor terminal. Position capacitor and wiper motor against windshield frame, and install attaching lock washers and cap screws.

161. WIRING SYSTEM.

a. Description of Conduits (figs. 78 and 79).

All wiring is contained in protective conduits which act as shielding for the electrical circuits. These conduits are secured in position with clips or brackets fastened to the hull with toothed lock washers and screws.

b. Replacement. See paragraph 97 for removal and installation of conduits. NOTE: *It is very important that all conduits be securely clamped when installed.*

162. HULL AND BRACKETS.

a. Description. One bond strap is connected to the left side of the engine support beam and to the support beam left hull bracket. In addition, toothed lock washers are used between the hull and the terminal boxes, fenders, and sand shields, and other similar units. These washers bond the parts to the hull to eliminate static discharges which would create radio interference.

b. Replacement. Clean all paint from surfaces to effect good contact. Replace washers and bond straps in their original sequence, and make certain that all connections are tight.

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

PART FOUR – ARMAMENT

Section XXX

INTRODUCTION

163. SCOPE.

a. Part Four, Armament, is published for the information of the using arms and services.

b. Part Four, Armament, contains a description of the 105-mm Howitzer, M2 and M2A1 and 105-mm Howitzer Mount M4. It also contains technical information required for the identification, use and care of the weapon, ammunition and accessory equipment. Refer to paragraph 21 for armament lubrication.

164. DATA.

a. 105-mm Howitzer.

Caliber of howitzer	105-mm
Weight of howitzer	1,064 lb
Weight of projectile	33 lb
Weight of propelling charge, nominal	3.00 lb
Muzzle velocity	1,550 fps
Rifling:	
Twist	Right-hand, uniform 1 turn in 20 cal
Length of bore	22.5 cal
Elevation	33 deg
Depression	5 deg
Turns of handwheel to elevate 20 deg	35½
Traverse to the left of center line	12 deg
Traverse to the right of center line	26 deg
Type of recoil mechanism	Hydropneumatic
Normal recoil	42 in.
Type of equilibrator	Spring
Weight of recoil mechanism	463 lb
Weight of cradle	333 lb
Weight of equilibrator	72 lb

165. DIFFERENCES AMONG MODELS.

a. The difference between the M2 and M2A1 Howitzer is only in the details of construction of the breech ring. This difference does not affect troop use or care of the materiel.

OPERATION

173. FIRING THE HOWITZER.

a. There is only one method of firing the howitzer, that is by the lanyard. Point the howitzer on the target. Grasp the lanyard handle (fig. 159) and pull towards the side of the vehicle.

b. The mechanism is so designed that the lug on the firing shaft will not engage the trigger shaft (fig. 159) should the piece fail to return completely to battery. This is an important safety feature.

174. UNLOADING THE HOWITZER.

a. Opening the breech is intended to automatically eject the unfired round of the cartridge case of the fired round.

b. To extract a cartridge case that is stuck, insert the rammer staff into the bore and tap the bottom of the inside of the case lightly until it is loosened and can be pushed out of the chamber.

c. To unload an unfired round when the extractor fails to eject, insert the unloading rammer into the bore until the head encloses the fuze and comes in contact with the projectile. Then push and, if necessary, tap the rammer staff lightly until the round is dislodged from its seat. Then push it out of the breech.

d. If the extractor has ejected the cartridge case but has not ejected the projectile, fill the chamber with waste, close the breechblock and dislodge the projectile as described above. Then open the breech and remove the waste and the projectile.

175. PLACING HOWITZER IN TRAVELING POSITION.

a. Open breech and check to see that a round has not been left in bore of howitzer. Close breech.

b. The cradle traveling lock holds the cradle in a fixed position and is engaged when the howitzer is not in use. To lock the cradle in place, line up the traveling lock shaft ball ends so that the right end of the shaft fits snugly into the socket at point "A" (fig. 156). This can be done by maneuvering the elevating and traversing handwheel until the cradle is positioned. Then close the traveling lock lever by revolving it clockwise until the cradle is locked securely in place between the socket at point "B" (fig. 156).

c. Clean and lubricate howitzer.

d. Install howitzer covers.

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

Section XXXII

SIGHTING AND FIRE CONTROL EQUIPMENT

176. GENERAL.

a. The laying equipment for the 105-mm howitzer is made up of the Telescope Mount M21 with Panoramic Telescope M12A2, the Range Quadrant M4, and the Telescope Mount M42 or T54 with Elbow Telescope M16. The equipment is designed to point the howitzer in azimuth and elevation for either direct or indirect fire. Arrangement of this equipment is shown in figure 160.

b. The Telescope Mount M21, with its Panoramic Telescope M12A2, is used for aiming the howitzer in azimuth for either direct or indirect fire. For indirect fire, the howitzer is laid in elevation by the Range Quadrant M4. For direct fire, the howitzer is aimed in elevation by using the graduated range scale which is seen in the telescope reticle. Both the panoramic telescope and the elbow telescope have reticle range scales. Either telescope may be used for aiming in elevation. When the panoramic telescope is used, the equipment functions as a one-sight, one-man system. When the elbow telescope is used the equipment functions as a two-sight, two-man system.

c. The Aiming Post M1 is used as an aiming post for indirect fire. The Aiming Post Light M14 is used on the aiming post for night firing.

d. The gunner's quadrant is used for determining elevation of the howitzer. Either the Gunner's Quadrant M1 or the Gunner's Quadrant M1918 may be furnished.

e. The bore sight and testing target are used during the bore sighting operation for verification and alinement of sights.

177. TELESCOPE MOUNT M21 WITH PANORAMIC TELESCOPE M12A2, RANGE QUADRANT M4, TELESCOPE M12A2, RANGE QUADRANT M4, TELESCOPE MOUNT M42 OR T54 WITH ELBOW TELESCOPE M16.

a. Description of Telescope Mount M21.

(1) The telescope mount (fig. 161) is essentially a device for mounting the panoramic telescope and for positioning it accurately in a vertical plane. This telescope mount also incorporates an azimuth compensating mechanism. As long as the mount is cross-leveled, the azimuth compensating mechanism applies azimuth correction when the howitzer is elevated with the trunnions out of level.

(2) The telescope mount fits over the left cradle trunnion and is attached to the cradle.

(3) Provision is made for cross-leveling and longitudinal-leveling; a level vial and knob being provided for each motion (fig. 161).

Telescope Mount M42 (fig. 166) on the right side of the gun and is used in laying for elevation for direct fire on moving targets.

(2) The reticle (fig. 164) is provided with range lines only, with the normal line (marked "N") at the optical axis of the telescope. The lines represent elevations for ranges from zero to 1,600 yards, in steps of 200 yards. The identifying number "105-H-3,5" shows the associated Firing Table.

(3) The Elbow Telescope M16, and Telescope Mount M42, in conjunction with the Telescope Mount M21, and Panoramic Telescope M12A2, form a two-sight, two-man system for laying the gun in direct fire against moving targets. This system permits more rapid fire and is more efficient than the one-sight, one-man system, since it divides the duties of laying between the gunner who lays for direction and the No. 1 cannoneer of the gun squad who lays for elevation.

f. Cross-leveling.

(1) When the trunnions are out of level, elevation of the howitzer causes an error in laying for direction. To compensate for this error, the azimuth compensating mechanism in the Telescope Mount M21 automatically turns the panoramic telescope, throwing the line of sighting off the target. When the cross lines in the telescope are brought back onto the target by means of the traversing handwheel, the howitzer will have been brought back to its correct setting.

(2) For proper operation of the compensating mechanism, it is essential that the Telescope Mount M21 be kept cross-leveled at all times during the operations of both direct and indirect laying. If the telescope mount is not level, the reticle lines will move off the target erroneously as the howitzer is elevated, and incorrect setting will be applied to the howitzer.

(3) To cross-level the telescope mount, turn the cross-leveling knob until the bubble in the cross level is centered.

g. Operation of the Telescope Mount M21 and Panoramic Telescope M12A2.

(1) To place the telescope in its socket, remove the telescope from the carrying case, turn the wing knob on the socket to its extreme counterclockwise position, and place the telescope gently in the socket. Exert slight downward pressure to ensure that the telescope is properly seated. Release the wing knob. Uncover both levels of the telescope mount. Operating procedure depends upon whether direct or indirect laying is to be employed, instructions for which are given separately.

(2) DIRECT LAYING BY ONE-MAN, ONE-SIGHT SYSTEM.

(a) Set the fine and coarse elevation indexes on the panoramic telescope rotating head at zero and leave them in this position. Match

the elevation indexes on the telescope mount by means of the longitudinal leveling knob and leave them in this position. Cross-level the telescope mount.

(b) Set the azimuth micrometer to zero against the index. Lateral deflections up to 40 mils, either right or left, may be read directly from the reticle, thus eliminating the necessity of using the azimuth mechanism.

(c) The gunner follows the target with the appropriate lead and range by placing it on the corresponding reticle lines of the panoramic telescope. The gunner uses the traversing and elevating handwheels on the left side of the howitzer carriage to follow the target.

(3) DIRECT LAYING BY TWO-MAN, TWO-SIGHT SYSTEM. The gunner follows the target with the appropriate lead, using the reticle of the panoramic telescope and the traversing handwheel on the howitzer carriage. The No. 1 cannoneer follows the target with the appropriate range line of the reticle in the Elbow Telescope M16 (fig. 166) by rotating the elevating handwheel on the right of the howitzer carriage.

(4) INDIRECT LAYING.

(a) Set the deflection (firing angle) on the azimuth scale and micrometer of the panoramic telescope. Center the bubbles in the cross- and longitudinal-level vials of the telescope mount and keep them continuously centered during fire by means of the cross- and longitudinal-leveling mechanisms.

(b) To aim the howitzer in azimuth, operate the traversing handwheel on the howitzer carriage so that the central vertical line of the telescope reticle remains continuously on the aiming point. It is not necessary to bring the aiming point exactly on the zero horizontal line, but if the aiming point does not fall within the field of view, rotate the elevation knob until it does. This procedure is permissible in indirect fire only.

(c) Use the range quadrant to lay the howitzer in elevation.

(5) For Panoramic Telescope M12A2, changes in deflection can be introduced by using either of the two methods described below.

(a) With the azimuth micrometer index set to zero against the deflection scale, rotate the azimuth micrometer (by means of the azimuth worm knob) in the proper direction the required number of 1-mil divisions.

(b) Each time the deflection is set or changed, rotate the micrometer index to zero against the azimuth micrometer. Successive deflection shifts are introduced, as in making an original deflection setting. The deflection—right or left—can be read at any time on the deflection scale.

(6) PREPARATION FOR TRAVEL. Turn the wing knob counterclockwise and lift out the panoramic telescope. Place the telescope in the carrying case. Protect both levels by closing their covers.

h. Operation of Range Quadrant M4.

(1) To change range drums, first rotate the elevation worm knob or the range drum knob until the elevation scale index registers 100-mils depression. In this position, the shoe on the range pointer support will be in the open part of the slot at the end of the range drum, so that the drum can be removed easily and a new one inserted in the proper position without the necessity of threading it past the index. To remove the drum, unscrew the wing nut from the end of the range drum knob and then withdraw the knob and drum. Slide the new drum over the adapter on the worm shaft and engage the notch on the inner adapter with the lug on the drum, thus accurately positioning the drum. The shoe on the range pointer support should slip into position at the beginning of the range drum slot. In replacing the knob, aline the holes in the knob with the pins on the outer adapter, and slide it into place. Tighten securely by means of the wing nut.

(2) To operate the range quadrant, any one of the three following combinations of data may be employed.

(a) Angle of site in mils, angle of elevation in mils.

(b) Angle of site in mils, range in yards. CAUTION: THE RANGE DRUM IS ACCURATE ONLY FOR THE AMMUNITION FOR WHICH IT IS GRADUATED.

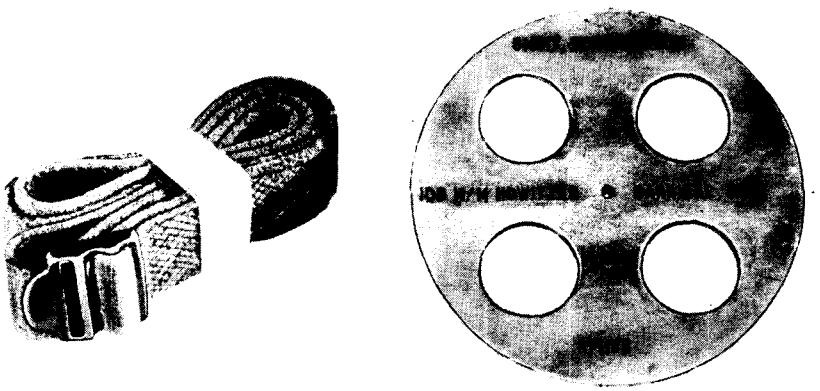
(c) Quadrant elevation in mils. Set at angle of elevation, with the angle of site set at normal, since the quadrant elevation already includes any necessary angle of site.

(3) Having made the necessary settings in accordance with the combination selected from the above listing, cross-level the range quadrant by means of the cross-leveling knob. Then elevate or depress the howitzer until the longitudinal-level bubble is centered, checking the cross-level bubble at all times. The howitzer is then properly laid in elevation. Maintain both bubbles in their centered position as long as firing is continued.

(4) PREPARATION FOR TRAVEL. Close the covers on the level vials.

i. Operation of Telescope Mount M42 and Elbow Telescope M16.

(1) DIRECT LAYING. The howitzer is elevated or depressed until the base of the target appears on the reticle graduation corresponding to the target range. By this operation, the howitzer is laid for range and angle of site.



RA PD 49878

Figure 167 — Bore Sighting Equipment

(2) PREPARATION FOR TRAVEL. The elbow telescope will remain assembled to its mount. Care must therefore be exercised to avoid damage to the telescope during travel or while it is not in use.

178. BORE SIGHT.

a. The bore sight (fig. 167) is used to indicate the direction of the axis of bore of the piece for orientation purposes. Each bore sight is composed of a breech elemen and a muzzle element.

b. The breech bore sight is a metal disk which fits accurately in the breech chamber of the howitzer. The model of the howitzer for which it is to be used is engraved on the disk.

c. The muzzle bore sight includes a quantity of black linen cord —to be stretched tightly across the muzzle, vertically and horizontally, in the score marks thereon—and a web belt to be buckled around the muzzle to hold the cord in place.

d. With the two elements in place, look through the aperture in the breech bore sight. The direction of the axis is indicated by the cord intersection.

e. Handle the breech element of the bore sight carefully to prevent occurrence of nicks and burs. Keep the breech element lightly coated with special lubricating grease when not in use. Wind the cord and web belt into a compact bundle.

179. TESTING TARGET.

a. The testing target is used during the bore sighting operating for the alinement of sights with the axis of the bore. The aiming points are plainly designated. It is essential that the proper aiming points be selected for the materiel and equipment employed, and that

surface of the mount socket will provide a surface for seating the gunner's quadrant. The gunner's quadrant should show the surface to be level along both axes. An error not in excess of one division of the telescope mount level vial is acceptable. If the error is beyond this limit, it will be necessary to adjust the corresponding level vial. This adjustment is to be performed only by authorized ordnance personnel.

f. Elevation Indexes of the Telescope Mount M21. Level the howitzer with the gunner's quadrant and center the cross-level and longitudinal-level bubbles of the telescope mount. The elevation indexes on the actuating arm and rocker of the mount should coincide. If they do not, loosen the two screws on the adjustable index, and slide the movable index into coincidence with the fixed index. Tighten the screws and recheck the level bubbles.

g. Verification of Elevation Adjustment for Panoramic Telescope M12A2. Assemble the panoramic telescope to the telescope mount. With the elevation indexes of the telescope mount in coincidence, the trunnions level, and the cross-level bubble centered, boresight on the testing target or the terrain object. Place the zero range line (optical center) of the reticle on the corresponding line of the testing target or on the terrain object. The elevation micrometer and the elevation index should indicate zero. If the coarse elevation index does not indicate zero, the adjustment should be made by ordnance personnel.

h. Verification of Azimuth Adjustment for Panoramic Telescope M12A2.

(1) Set the deflection index to zero against the fixed scale (zero deflection). Turn the azimuth micrometer knob to place the micrometer zero opposite the index. The main azimuth scale should now read zero also.

(2) If the main azimuth scale does not read zero, turn the micrometer knob until it does. This will throw the micrometer scale out of coincidence with its index.

(3) To bring the micrometer scale back into coincidence with its index, loosen the screws in the end of the micrometer knob and, while holding the azimuth worm knob, slip the micrometer knob until coincidence is secured. Tighten and recheck. The purpose of this adjustment is to secure simultaneous zero readings of the azimuth scale and micrometer so as to avoid possible whole-turn errors in micrometer settings during operating.

(4) With the telescope mounted in its socket, set the azimuth scale, micrometer, and deflection index to zero. Boresight the gun. The verticle line of the telescope reticle (optical center) should then fall on the corresponding line of the testing target or on the terrain object. If it does not, the telescope must be rotated in its socket.

This is accomplished by loosening the tangent screw lock screw (at the front of the telescope socket) and rotating the telescope by backing off the tangent adjusting screw on the side toward which the line of sight is to be moved and tightening the opposite tangent screw until the vertical line of the reticle (optical center) coincides with the proper line on the test target or on the terrain object (fig. 168). Tighten the other tangent screw until a snug fit without binding is obtained. Tighten the lock screws and note whether tightening has shifted the setting. It may be necessary to alternate the final tightening, bearing gradually more and more on each screw until they are tight and the alinement is maintained. The line of sighting is now on the test target or terrain object, and the scale and micrometer indicate zero, completing the adjustment.

(5) To insure that the adjusting screws are not so tight as to cause binding, remove the telescope from its socket, replace, and check the alinement on the testing target.

(6) The condition might arise wherein the tangent screws in the telescope socket do not provide sufficient adjustment to center the vertical line of the reticle on the corresponding line of the testing target. If this condition is found, center the adjusting screws and aline the vertical line of the reticle on the corresponding line of the testing target by turning the azimuth worm knob. The azimuth scale or micrometer, or both, will no longer read zero. With a screwdriver, loosen the screws which hold the main azimuth scale to the rotating head. Slip the scale until its zero graduation registers with the index. Tighten the screws. To adjust the micrometer, loosen the screws in the end of the micrometer knob and, while holding the azimuth worm knob, slip the micrometer knob until coincidence is secured. Tighten and recheck.

i. Verification of Range Quadrant M4. Level the howitzer and carriage horizontally (axis of bore and axis of trunnions). Center the cross-level bubble in the range quadrant.

(1) ELEVATION SCALES. Set the engraved line on the range drum adapter against the engraved line on the quadrant body. The elevation scale and the elevation micrometer should read zero. The range pointer, if the range drum is properly assembled to the range index, will indicate a reading slightly greater than zero, which is an allowance for jump and for which compensation is automatically made when the range drum is assembled to the range quadrant. If the elevation micrometer scale does not read zero, loosen the three screws in the knob, and, without moving the knob, slip the zero of the micrometer scale into coincidence with the index. Tighten the screws and recheck. If the elevation scale does not indicate zero, loosen the two screws in the index plate and move the index opposite the zero graduation. Tighten the screws and recheck.

(2) ANGLE OF SIGHT. With the howitzer at zero elevation, the elevation scales at zero, the cross-level bubble centered, and the longitudinal-level bubble centered, the angle of site scale should read 3 (300 degrees) and the angle of site micrometer should read zero. If the angle of site scale does not read 3 (300 degrees), loosen the two screws on the scale and move the figure 3 into coincidence with the index. If the angle of site micrometer does not read zero, loosen the screw in the micrometer knob, and, holding the micrometer knob so as to keep the bubble centered, move the zero into coincidence with the index. Tighten the screws and recheck.

j. Verification of Telescope Mount M42 and Elbow Telescope M16. The mount M42 may be adjusted to center the telescope reticle both in azimuth and elevation. With the axis of the trunnions leveled, boresight on the test target or the distant terrain object. Sight through the elbow telescope. If the dot in the center of the "N" cross hair is not on the intersection of the test target cross lines, put it on in the following manner:

(1) Loosen the elevation clamping screw. Loosen the elevation adjusting screw lock nuts. With a screwdriver, loosen one adjusting screw and tighten the other. This will change the telescope a slight amount in elevation. Bring the center of the "N" cross hair to bear exactly on the horizontal line of the target.

(2) Tighten the lock nuts, and note whether tightening has shifted the setting. Tighten the elevation clamping screw. It may be necessary to alternate the final tightening, bearing gradually more and more on each nut until they are tight and alinement is maintained.

(3) The dot in the center of the "N" cross hair may be brought into coincidence with the vertical cross line of the test target by alternate adjustment of the azimuth adjusting screws in the same manner as that described above.

k. Verification of Telescope Mount M23 and Elbow Telescope M16. With the axis of the trunnions leveled, bore-sight on the test target or the distant terrain object. By observation level the reticle with respect to the field by means of the bracket rotating knob. If the "N" cross hair is not on its line of the test target, put it on in the following manner:

(1) Loosen the worm clamping bolt.

(2) With a screwdriver, move the elevating adjusting worm to bring the "N" range line in coincidence with the proper line of the test target or the terrain object.

(3) Tighten the worm clamping bolt.

(4) Recheck.

CARRIAGE, MOTOR, 105-MM HOWITZER, M7

Section XXXIII

AMMUNITION

181. GENERAL.

a. Ammunition for the 105-mm howitzer, M2A1, is issued and shipped in the form of fuzed complete rounds of semifixed ammunition. In semifixed ammunition, the fuzed projectile is seated loosely in the neck of the cartridge case containing the primer and propelling charge; the round is loaded into the weapon as a unit. The propelling charge of semifixed ammunition usually is divided into sections, to permit adjustment in the field for zone firing. However, in the H.E., A.T. round, which is a special type, the propelling charge is not adjustable. A complete round includes all the components required to fire a weapon once.

182. FIRING TABLES.

a. Firing data for ammunition fired in the M2A1 howitzer when mounted on the M7 motor carriage is provided in FT 105-H-3 and changes thereto. An index of firing tables is maintained in FM 21-6.

183. AUTHORIZED ROUNDS.

a. Authorized ammunition for the M2A1 howitzer is listed in Table I together with essential data, and is shown in figures 169 to 173. Standard nomenclature is used in the listing of authorized rounds. Its use is mandatory for purposes of record, except where the use of the Ammunition Identification Code (A.I.C.) symbol is prescribed to facilitate requisitioning and reporting in the field. Each complete round of semifixed ammunition in a specific packing is assigned an A.I.C. symbol. These symbols are published in ORD 11 SNL's.

b. Interchangeability. Ammunition for the M2A1 howitzer differs from the corresponding rounds for the M3 (airborne) howitzer only with respect to the propelling charge. Whereas the adjustable charges for the M2A1 howitzer are made up of seven sections, M3 howitzer rounds have a five-section charge of quick-burning powder. The charges, or sections thereof, are not directly interchangeable. However, the M1 high-explosive rounds for the M3 howitzer are substitute standard for use in the M2A1 howitzer, and can be fired therein by applying suitable corrections as given in FT 105-H-3 and changes.

184. PREPARATION FOR FIRING.

a. The H.E., A.T. round is ready for firing once the packing is removed and the projectile is properly seated in the cartridge case.

b. Fuzed rounds with adjustable propelling charges require the following preparation before firing:

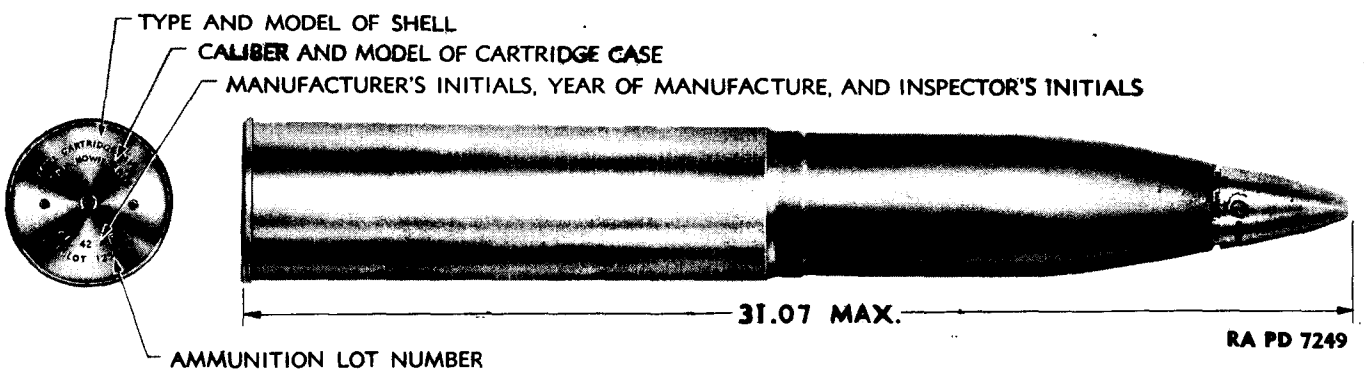


Figure 173 — Cartridge, Drill, Semifixed, M14, w/Fuse, Dummy, M59, 105-mm How. M2, M2A1 and M4 and M3

TABLE I

AUTHORIZED AMMUNITION FOR 105-MM HOWITZER M2A1

STANDARD NOMENCLATURE OF COMPLETE ROUND‡	COMPLETE ROUND		PROJECTILE			ACTION OF FUZE†	PROPELLING CHARGE	
	Weight* (lb.)	Length (in.)	Weight As Fired (lb.)	CHARGE Kind	CHARGE Weight (lb.)		Type	Weight (lb.)
Service Ammunition								
SHELL, semifixed, H.E., A.T., M67, w/FUZE, B.D., M62 or M62A1, 105-mm how., M2, M2A1, and M4	36.85	31.05	29.22	Pento-lite	2.93	Non-delay	§	‖1.60
SHELL, semifixed, H.E., M1, w/FUZE, P.D., M48, 105-mm how., M2, M2A1 and M4	42.06	31.07	33.00	TNT	4.84	SQ & delay	‖	3.03
SHELL, semifixed, H.E., M1, w/FUZE, P.D., M48A1, 105-mm how., M2, M2A1, and M4	42.06	31.07	33.00	TNT	4.84	SQ & delay	‖	3.03
SHELL, semifixed, H.E., M1, w/FUZE, P.D., M48A2, SQ & 0.15-sec. delay, 105-mm how., M2, M2A1, and M4	42.06	31.07	33.00	TNT	4.84	SQ & delay	‖	3.03
SHELL, semifixed, H.E., M1, w/FUZE, P.D., M54, 105-mm how., M2, M2A1, and M4	42.06	31.09	33.00	TNT	4.84	Time & SQ	‖	3.03
SHELL, semifixed, gas, persistent, H, M60, w/FUZE, P.D., M57, 105-mm how., M2, M2A1, and M4	42.49	31.08	33.42	H gas	3.17	SQ	‖	3.04
SHELL, semifixed, gas, persistent, CNS, M60, w/FUZE, P.D., M57, 105-mm how., M2, M2A1, and M4	NA	31.08	NA	CNS gas	NA	SQ	‖	3.04
SHELL, semifixed, smoke, FS, M60, w/FUZE, P.D., M57, 105-mm how., M2, M2A1, and M4	43.93	31.08	34.86	FS smoke	4.61	SQ	‖	3.04
SHELL, semifixed, smoke, phosphorus, WP, M60, w/FUZE, P.D., M57, 105-mm how., M2, M2A1, and M4	43.42	31.08	34.35	WP smoke	4.06	SQ	‖	3.04
SHELL, semifixed, smoke, HC (white), B.E., M84, w/FUZE, P.D., M54, 105-mm how., M2, M2A1, and M4	41.94	30.49	32.87	HC smoke	7.50	Time & SQ	‖	3.04
SHELL, semifixed, smoke, HC, green, HC, green, B.E., M84, w/FUZE, P.D., M54, 105-mm how., M2, M2A1, and M4	NA	30.49	NA	HC green	NA	Time & SQ	‖	3.04

SHELL, semifixed, smoke, HC, red, B.E., M84, w/FUZE P.D., M54, 105-mm how., M2, M2A1, and M4	NA	30.49	NA	HC red	NA	Time & SQ	‖	3.04
SHELL, semifixed, smoke, HC, violet, B.E., M84, w/FUZE, P.D., M54, 105-mm how., M2, M2A1, and M4	NA	30.49	NA	HC violet	NA	Time & SQ	‖	3.04
SHELL, semifixed, smoke, HC, yellow, B.E., M84, w/FUZE, P.D., M54, 105-mm how., M2, M2A1, and M4	NA	30.49	NA	HC yellow	NA	Time & SQ	‖	3.04
Practice Ammunition								
SHELL, semifixed, empty, for sand loading, M1, w/FUZE, inert, P.D., M48, 105-mm how., M2, M2A1, and M4	42.06	31.07	33.00	Empty♮	.....	Inert	‖	3.03
Blank Ammunition								
AMMUNITION, blank (1.5-lb. or 2-lb. charge), 105-mm how., M2, M2A1, M3, and M4	6.23	6.00	.....	.....	.....	.....	Blk. Pwdr.	1.5, or 2.0
Drill (dummy Ammunition)								
CARTRIDGE, drill, semifixed, M14, w/FUZE, dummy, M59, 105-mm how., M2, M2A1, and M4°	41.35	31.07	29.85	.....	.....	Inert	§	3.10

B.D.—base-detonating
B.E.—base-ejection
FNH—flashless nonhygroscopic
gr.—grain
H.E.—high-explosive
H.E., A.T.—high-explosive-antitank
P.D.—point-detonating
SQ—superquick
sec.—second
WP—white phosphorus

‡ Service and practice ammunition is manufactured with both brass and steel cartridge cases. Nomenclature of steel-case rounds same as shown in listing above for brass-case rounds except that words "steel case" follow shell model number.

* Data is for rounds assembled with brass cartridge case. Steel-cased rounds weigh approximately 0.5 pound less.

† FUZE, P.D., M48 has 0.05 second delay; FUZE, P.D., M48A1 has 0.15 second delay; FUZE, P.D., M48A2 may have 0.05 second or 0.15 second delay, depending on the lot. Identification is provided for by stamping on the fuze. FUZE, P.D., M54 gives selective time action up to 25 seconds, in 0.2-second graduations.

¶ The propelling charge is nonadjustable, the powder being retained in a single cloth bag fixed to the base end of the cartridge case.

‖ These propelling charges are divided into seven sections, for adjustment in the field. Each section is held in a separate cloth bag. The increments sections are loosely linked to each other to permit ready withdrawal and removal. The number of the charge is stenciled on the forward (uppermost) end of each increment.

♮ Empty, for sand-loading to required weight.

° An inert service fuze (M54) may be fitted to the cartridge in place of the M59 dummy fuze.

§ This is an inert sectioned charge constructed to simulate the service adjustable propelling charge.

NA—Not available at time of publication.

(1) After removing the round from its packing, withdraw the U-shaped packing stop from the fuze wrench slots in the fuze. This stop is used to prevent the fuze from touching the separator or end of the fiber container. Serious damage may result if this stop is not removed before firing.

(2) Adjust the propelling charge for the zone to be fired. When the full (outer zone) charge is to be fired, no adjustment is necessary, but the charge should be inspected to make certain that all proper sections are present. For inner zones, withdraw the increments from the cartridge case, and remove and discard those increments numbered higher than the charge to be fired, by cutting or breaking the twine between the designated charge and the higher numbered increments. Reassemble the remaining increments in the cartridge case in their proper numerical order with the number of each increment uppermost. Thus, when adjusting the propelling charge to fire charge 4, increments 5, 6 and 7 will be removed, and the remaining parts, to and including 4, will be reassembled in the cartridge case.

(3) Upon completion of the above preparation, rounds fuzed with the M57 fuze are ready for firing, since this is a single action fuze requiring no special preparation. In the case of rounds with M48-series or M54 fuzes, the fuze must be set for the required action, as described in the following paragraphs.

(4) FUZES, P.D., M48, M48A1, AND M48A2. As shipped, these fuzes are set for superquick action (SQ), that is, the slot in the setting screw is parallel to the axis of the fuze and in line with "SQ". To adjust for delay action, the setting screw should be turned by means of the screwdriver end of WRENCH, fuze, M7A1, or similar instrument, so that the slot is alined with "DELAY," that is, at right angles to the axis of the fuze. (Delay action is provided for in the fuze by a delay pellet.) The setting may be made or changed at will, and can be done in the dark by noting the position of the slot in the setting sleeve.

(5) FUZE, P.D., M54. Prior to firing, with either superquick or time setting, the safety pull wire securing the time plunger during shipment must be withdrawn from the fuze (pull lower end of wire from the hole and slide wire off end of fuze). To obtain superquick action, the fuze may be left at the safe (S) setting, as shipped, or may be set for a time longer than the expected time of flight. Since the superquick action is always operative, it will function on impact unless prior functioning has been caused by time action. If time action is required, the graduated time-ring (graduated to 25 seconds) is set for the required time of burning by means of a fuze setter. NOTE: *If, after setting the fuze preparatory to firing, the round is not fired, the fuze should be reset "safe" and the safety pull wire replaced in its proper position before returning the round to its packing.*

APPENDIX

Section XXXIV

SHIPMENT AND LIMITED STORAGE

185. GENERAL INSTRUCTIONS.

a. General. Preparation for domestic shipment of 105-mm howitzer motor carriage M7 by rail includes instructions for loading the vehicles, blocking necessary to secure the vehicles on freight cars, clearance, weight, and other information necessary to prepare the vehicle for domestic rail shipment. For more definite information and for preparation of the vehicles for indefinite storage, refer to AR 850-18.

186. PREPARATION FOR LIMITED STORAGE.

a. Vehicles to be prepared for limited storage are those ready for immediate service, but not used for less than 30 days. If vehicles are to be indefinitely stored after shipment by rail, they should be prepared for such storage at their destination.

b. If the vehicles are to be placed in limited storage, take the following precautions:

(1) LUBRICATION. Lubricate the vehicle completely (par. 21).

(2) BATTERY. Check battery and terminals for corrosion, and if necessary, clean and thoroughly service battery.

(3) ROAD TEST. The preparation for limited storage includes a road test after the battery and lubrication service to check the general condition of the vehicle. Correct any defects noted in the vehicle operation before the vehicle is stored, or note on a tag attached to the steering levers, stating the repairs needed or describing the condition present. Make a written report of these items to the officer in charge.

(4) FUEL IN TANKS. It is not necessary to remove fuel from the vehicle tanks for shipment within the United States, nor to label the tanks under Interstate Commerce Commission Regulations. Leave fuel in the tanks except when storing in locations where fire ordnance or other local regulations require removal of all gasoline before storage.

(5) EXTERIOR OF VEHICLE. Remove rust appearing on any part of the vehicle exterior with flint paper. Repaint painted surfaces whenever necessary to protect metal. Coat exposed polished metal surfaces susceptible to rust with medium grade preservative lubricating oil. Close firmly all hatches and other openings. Make sure paulins are in place and firmly secured. Leave rubber floor mats,

when provided, in an unrolled position on the floor, not rolled or curled up. Equipment such as pioneer tools, track tools, and fire extinguishers can remain in place on the vehicle.

(6) INSPECTION. Make a systematic inspection just before shipment or temporary storage to ensure all above steps have been covered and that the vehicle is ready for operation on call. Make a list of all missing or damaged items and attach it to the steering levers. Refer to Before-operation Service (par. 26).

(7) BRAKES. Release brakes and check tracks.

c. Inspections in Limited Storage. Inspect vehicles in limited storage for condition of the battery. If water is added to the battery when freezing weather is anticipated, recharge the battery with a portable charger or remove and charge the battery. Do not attempt to charge the battery by running the engine.

187. LOADING AND BLOCKING FOR RAIL SHIPMENT.

a. Preparation. In addition to the preparation described in preceding paragraph, when ordnance vehicles are prepared for domestic shipment, take the following steps:

(1) EXTERIOR. Cover the vehicle with the canvas cover supplied as an accessory, or which is available for use during rail shipment.

(2) BATTERY. Disconnect the battery to prevent its discharge by vandalism or accident. This may be accomplished by disconnecting the positive lead, taping the end of the lead, and tying it back away from the battery.

(3) BRAKES. The brakes must be applied and the transmission placed in low gear after the vehicle has been placed in position with a brake wheel clearance of at least 6 inches (fig. 166). Locate the vehicles on the car in such a manner as to prevent the car from carrying an unbalanced load.

(4) MARKING CARS. All cars containing ordnance vehicles must be placarded "DO NOT HUMP."

(5) TYPES OF CARS. Ordnance vehicles may be shipped on flat cars, end door box cars, side door box cars, or drop end gondola cars, whichever type is most convenient.

b. Facilities for Loading. Whenever possible, load and unload vehicles from open cars under their own power, using permanent end ramps and spanning platforms. Movement from one flat car to another along the length of the train is made possible by cross-over plates or spanning platforms. If no permanent end ramp is available, an improvised ramp can be made from railroad ties. Vehicles may be loaded in gondola cars without drop ends by using a crane. In

SHIPMENT AND LIMITED STORAGE

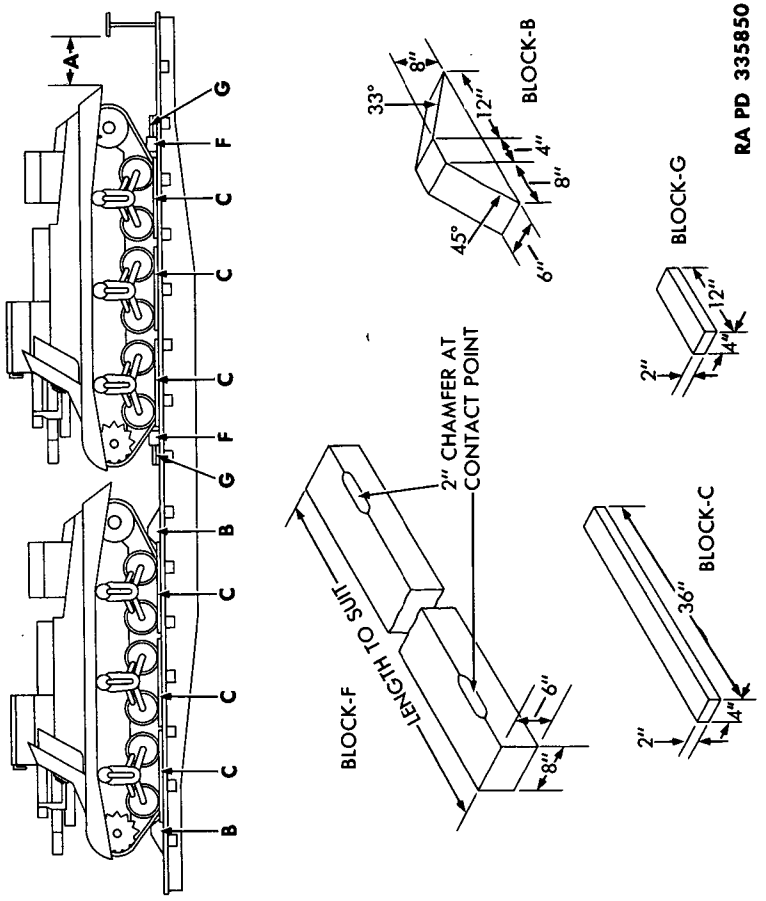


Figure 174 — Blocking Requirements for Rail Shipment

case of shipment in side-door box cars, use a dolly-type jack to warp the vehicles into position within the car.

c. **Securing Vehicles.** In securing or blocking a vehicle, three motions—lengthwise, sidewise, and bouncing, must be prevented. The following are approved methods of blocking and securing these vehicles on freight cars.

(1) METHOD 1. Place four blocks (B, fig. 166), one to the front and one to the rear of each track. Nail the heel of each block to the car floor with five 40-penny nails. Toenail to the car floor with two 40-penny nails, that portion of each block which is under the track. Locate two blocks "C" on each side of the vehicle on the outside of each track. Nail each block to the car floor with three 40-penny nails. These blocks may be located on the inside of the tracks if conditions warrant.

(2) METHOD 2. Place two blocks (F, fig. 166), one to the front and one to the rear of the tracks. These blocks are to be at least as long as the over-all width of the vehicle at the car floor. Locate eight blocks "G" against the blocks "F" to the front and to the rear of each track. Nail the lower block to the floor with three 40-penny nails and the top block to the lower block with three 40-penny nails. Locate and secure blocks "C" as explained in Method 1.

Length (over-all)	222 9/32 in.
Width	113 5/16 in.
Height	100 in.
Area of car floor occupied per vehicle (sq ft)	175.75
Volume occupied per vehicle (cu ft)	1,458.72
Shipping weight per vehicle	52,000
Bearing pressure (lb per sq ft)	296

Section XXXV

REFERENCES

188. PUBLICATIONS INDEXES.

a. The following publications indexes should be consulted frequently for latest changes to or revisions of the publications given in this list of references and for new publications relating to materiel covered in this manual:

Introduction to Ordnance Catalog (explains SNL system)	ASF Cat. ORD-1 IOC
Ordnance publications for supply index (index to SNL's)	ASF Cat. ORD-2 OPSI
Index to Ordnance Publications (lists FM's, TM's, TC's and TB's of interest to Ordnance personnel, MWO's, OPSR's, BSD, S of SR's, OSSC's and OFSB's. Includes alphabetical listing of Ordnance major items with publications pertaining thereto)	OFSB 1-1
List of publications for training (lists MR's, MTP's, T/BA's, T/A's, FM's, TM's, TR's, TB's, SB's, MWO's, WDLO's, numbered pamphlets and firing tables concerning training)	FM 21-6
List of training films, film strips and film bulletins (lists TF's, FS's, and FB's by serial number and subject)	FM 21-7
Military training aids (lists graphic training aids, models, devices, and displays)	FM 21-8

189. STANDARD NOMENCLATURE LISTS.

a. Vehicular.

Carriage, motor, 105-mm howitzer, M7B1	SNL G-128

b. Ammunition.

Ammunition, fixed and semifixed, including subcaliber, for pack, light and medium field, aircraft, tank and antitank artillery, including complete round data	SNL R-1
Ammunition, blank, for pack, light and medium field artillery	SNL R-5
Ammunition instruction material for pack, light and medium field, aircraft, tank, and antitank artillery	SNL R-6

c. Armament.

Gun, machine, cal. .50, Browning, M2, heavy barrel, fixed and flexible; and ground mounts	SNL A-39
Gun, machine, cal. .30, Browning, M1919A4, fixed and flexible, M1919A5, fixed and M1916A6 flexible	SNL A-6
Howitzer, 105-mm, M2 and M2A1	SNL G-21

d. Sighting Equipment.

Mount, telescope, M21	SNL F-197
Quadrant, range, M4	SNL F-197

e. Maintenance.

Cleaning, preserving and lubricating materials: recoil fluids, special oils, and miscellaneous related items	SNL K-1
Soldering, brazing and welding material, gases and related items	SNL K-2
Tools, maintenance, for repair of automatic guns, automatic gun aircraft materiel, automatic and semiautomatic cannon and mortars—Individual items and parts	SNL A-35
Tool sets (common), specialists and organizational	SNL G-27 Section 2

190. EXPLANATORY PUBLICATIONS.

a. Fundamental Principles.

Automotive electricity	TM 10-580
Ammunition, general	TM 9-1900
Auxiliary fire-control instruments (field glasses, eyeglasses, telescopes and glasses)	TM 9-575
Basic maintenance manual	TM 38-250
Browning machine gun, cal. .30, HB, M1919A4 (mounted in combat vehicles)	FM 23-50
Browning machine gun, cal. .50, HB, M2 (mounted in combat vehicles)	FM 23-65
Driver's manual	TM 10-460
Driver selection and training	TM 21-300
Electrical fundamentals	TM 1-455
Field artillery and field motor ammunition	OFSB 3-3
Fuels and carburetion	TM 10-550

REFERENCES

Instruction guide, small arms data	TM 9-2200
Military motor vehicles	AR 850-15
Motor vehicle inspections and preventive maintenance service	TM 9-2810
Ordnance service in the field	FM 9-5
Precautions in handling gasoline	AR 850-20
Qualifications in arms and ammunition training allowances	AR 775-10
Radio fundamentals	TM 11-455
Range regulations for firing ammunition for training and target practice	AR 750-10
Small arms ammunition	TM 9-1990
Small arms ammunition	OFSB 3-5
Targets, target materials, and rifle range construction	TM 9-855
U. S. Rifle, cal. .30, M1903	FM 23-10
105-mm Howitzer, M2 and M2A1 and 105-mm Howitzer carriage M1A1 and M2	TM 9-325

b. Maintenance and Repair.

Artillery lubrication, general	OFSB 6-4
Cleaning, preserving, lubricating and welding materials and smilar items issued by the Ordnance Department	TM 9-850
General instructions for recoil fluid, light and medium field artillery	OFSB 6-6
Lubrication Order	WDLO 106
Maintenance and care of pneumatic tires and rubber treads	TM 31-200
Ordnance maintenance: Accessories for Wright R975-EC2 engines for medium tanks M3 and M4 (information on Scintilla magneto VAG9DFA)	TM 9-1750D
Ordnance maintenance: Continental engine model R975C-1	TM 9-1751
Ordnance maintenance: Carburetors (Stromberg)	TM 9-1826B
Ordnance maintenance: Electrical equipment (Delco-Remy)	TM 9-1825A
Ordnance maintenance: Fire extinguishers	TM 9-1799
Ordnance maintenance: Fuel pumps	TM 9-1828A

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Ordnance maintenance: Power train (one-piece differential case) for medium tanks M3, M4, and modifications, and related gun motor carriages ..... TM 9-1750B

Ordnance maintenance: Power train unit (three-piece differential case), for medium tanks M3, M4, and modifications ..... TM 9-1750

Ordnance maintenance: Speedometers, tachometers and recorders ..... TM 9-1829A

Ordnance maintenance: Tracks and suspension, turret and hull for medium tank M4 and modifications ..... TM 9-1750K

Ordnance maintenance: Browning machine gun, cal. .50—all types ..... TM 9-1225

Ordnance maintenance: Thompson submachine gun, cal. .45 M1928A1 ..... TM 9-1215

Ordnance maintenance: 105-mm howitzer M2 and M2A1; carriage M1A1 and M2 ..... TM 9-1325

c. Firing Tables.

HOWITZER, 104-mm, M2, M2A1 and M4.
CARRIAGE, howitzer, 105-mm, M1, M1A1, M2 and modifications.
CARRIAGE, motor, M7 and M7B1, 150-mm howitzer.
HOWITZER, 105-mm, M4, mounted in medium tank M4 and M4A3.
SHELL, semifixed, H.E., M1
W/FUSE, P.D., M48 and modifications.
W/FUSE, 25-second combination time and S.Q., M54.
SHELL, semifixed, smoke, B.E., 105-mm M84.
W/FUSE, 25-second combination time and S.Q., M54
SHELL, chemical, M60.
W/FUSE, P.D., M57.
SHELL, semifixed, H.E., A.T., M67 and M67A1.
W/FUSE, B.D., M62 ..... FT-105-H-3

d. Protection of Materiel.

Camouflage ..... FM 5-20

Chemical decontamination, materials and equipment ..... TM 3-220

Decontamination, of armored force vehicles.... FM 17-59

REFERENCES

Defense against chemical attack	FM 21-40
Explosives and demolitions	FM 5-25

Storage and Shipment.

Ordnance storage and shipment chart, group G —Major items	OSSC-G
Registration of motor vehicles	AR 850-10
Rules governing the loading of mechanized and motorized army equipment also major caliber guns, for the United States Army and Navy, on open top equipment published by Operations and Maintenance Department of Association of American Railroads.	
Storage of motor vehicle equipment	AR 850-18

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